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ENGINEERING AND MINING JOURNAL-PRESS

A CONSOLIDATION OF ENGINEERING AND MINING JOURNAL AND MINING AND SCIENTIFIC PRESS

Progress in Hydrometallurgy of Lead-Zinc Ores

By Arthur B. Parsons

Ore Injection at the Cananea-Duluth Mine

By Graham John Mitchell

Bronze memorial to Rossiter W. Raymond to be unveiled at next annual meeting of American Institute of Mining and Metallurgical Engineers. Dr. Raymond was Editor of Engineering and Mining Journal from 1867 to 1874, President of the Institute 1872-1874, and Secretary 1884-1911.

How Hargraves Found the Gold

By T. A. Rickard

The Oil Resurrection of Colorado

By H. A. Wheeler

Biography of William Arthur Caldecott

These big rollers minimize wear

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The large diameter rollers are carried on cross shafts mounted in solid bearings which rest on the steel frame-work.

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ENGINEERING AND
MINING JOURNAL-PRESS

JOSIAH EDWARD SPURR, Editor

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The World in General

THE GENERAL IMPRESSION in the United States at the beginning of 1925 is one of courage and optimism. Indeed, one cannot but be struck with the industrial and social resources and resiliency of the United States of America. Also England, despite the gravest of obstacles, is taking back her old place in finance and world policy, with the pound sterling well on the way to par. France is fighting to assume her ancient rôle, although her financial structure was hard hit; but there is apparently no intention to defraud the French peasants by making their bonds worthless, as the German rentiers were defrauded by the German government policy and left penniless. The German people who invested in the securities of their own country were like the Russian people who did the same: they had the faith—and they held the sack after the politicians were through.

Spain has fought a losing war in Africa, a tribute not so much to the prowess of the Moors as to the incompetency of Spain. Anyhow, it is a matter in which not much sympathy will be wasted on either side. Egyptian riots have complicated the problems between England and her African and Asiatic suzerainties. England's problem in Egypt is as difficult as the rôle of the United States in the Philippines, where the United States is still paying the penalty for a foolish move at the close of the Spanish war—the foolishness of taking over the Philippines. Russia has buried Lenine and unhorsed Trotzky: is still determined to be an Ishmael among nations. China and India are fermenting without much immediate prospect of anything but ferment coming out of it. Japan continues to show her right to rank among the world's foremost nations in every respect.

Prohibition recurs always as a major topic in the United States. It is only partly enforceable, it would appear. Drinks for the poor man are scarce and dangerous: for the well-to-do, there is no stoppage of the traffic, although the drinks are dear and poor.

The radio marks a major epoch in the world's history; it will tie the nations closer together: and will unite nation to nation in spirit. It is a culmination of wonders which put an end to the old way of thinking called materialistic. Music fills the air from many sources, but it is inaudible except for the sense artificially created by the invention of the radio. How many other impulses and waves and messages come to us, while we sit deaf, for lack of the special receiving sense? The radio message seems as impossible as the speech of disembodied spirits, as the waves of thought influence of the whole world beating in on us, unawares: only, hearing is believing, and there is no other test. But all things are possible.

In spite of riot and tumult and war and crime, the most marvelous and significant period of the world's history is swiftly evolving around us. Let us not miss the show; let us not fail to study and marvel at it; it is a wonderful spectacle, the most magnificent of all the eons: and we shall soon have to give up our seats to others.

A Cabinet Petroleum Committee

CONSIDERABLE SIGNIFICANCE is to be attached to the recent creation by President Coolidge of a Petroleum Committee in his Cabinet, consisting of four Cabinet officers—the Secretaries of the Interior, Commerce, War, and Navy. He had previously appointed a committee, of which Mr. George Otis Smith is chairman, to consider the petroleum policy of the Navy: the later Cabinet committee is to take up the broader problem of the proper policy for the petroleum reserves of the United States. And among these is the problem of conservation—a word which has openly been used by one of the secretaries in this connection, although it is not too popular a term.

As a people, we believe in conserving things from the other fellow, but not from ourselves. At any rate, the wasteful and ruinous methods by which we are ripping our petroleum out of the earth, and flooding the markets of the country and of the world with it, may receive serious consideration. It is one thing, of course, to appoint a committee, and another to have the committee get anywhere. The two acts often seem unrelated.

Our Cabinet officers have many calls on their time, and if they propose to settle the petroleum problem by personal investigation, it is unlikely that progress will be rapid. Nevertheless, it is one which warrants their individual attention. It is a problem of major importance; it is a matter for governmental concern and attention; it is something that vitally concerns the interest of the people and of the nation.

The Enemy's Country

ONE OF THE OUTSTANDING events of 1924 is that William Jennings Bryan was reported, late in the year, to have applied for membership in the American Association for the Advancement of Science. Whether his object is to impart knowledge or to acquire an education has not been made public. One suspects that he seeks the opportunity to present a paper, and having once gained the floor, that he will melt the hearts of the assembled scientists with a flood of the fiery eloquence which stampeded the country for him and after him more than once.

His famous speech on the Cross of Gold should be credential enough to admit him into any association of mineralogists and economic geologists; moreover, the American Association for the Advancement of Science is a catholic and liberal institution, turning the cold

shoulder on few, and welcoming in general the respectable citizen who has the price—which Colonel Bryan has. Moreover, Colonel Bryan is of the most respectable. He doubtless underrates the hard-boiled quality of the apparently meek and humble scientist, however: a group to stampede which would rank as a miracle. Anyhow, when Colonel Bryan makes his first impassioned address to prove that he was not ascended from a monkey, but has ascended from a primitive man called Adam, who, as the Hebrew tradition had it, lived naked in the woods with his equally primitive mate, it would be fine to be able to hear him. It is possible, indeed, that he would find a considerable degree of agreement among the assembled graybeards, who trace their ancestry back to the Neanderthal cave-man or the Java ape-man, but who refuse to consider that their ancestral line is represented by our low-browed and degenerate relatives, the anthropoid apes. Still, Colonel Bryan's credentials as a genealogist are not any too well certified.

Professor Angell Criticizes College Students

AS A RESULT of an investigation of student activities, Professor Robert C. Angell, of the University of Michigan, according to a recent issue of the *Herald-Tribune*, states significantly:

"College is no longer, if it ever was, solely a place for those who wish to become cultured. It is a social practice ground, where men and women learn to make friends and carry on mutual undertakings, where they acquire a certain amount of polish and enjoy, free from worries, the most delightful period of life. The student's interest in the external rather than in the vital is too apparent to require exposition. Three forms of achievement are coveted which give immediate and obvious glory. Places on athletic teams, editorships of student publications, and presidencies of students' organizations are sought with unflagging zeal, and scholarship is relegated to a subordinate position. What with athletic practice, committee meetings, play and musical club rehearsals, moving pictures, dances, intercollegiate games and, what is worse, hours and hours of idle talk about these and other diversions, little time is left for the principal purposes of college study."

These findings are so harmonious with our previous editorial of Jan. 3 that we cannot refrain from citing them. Professor Angell comments further upon the discouragement that arises from the superimposing of intercollegiate athletics upon the colleges and the evil influence of certain alumni in glorifying the less important features of college life.

Students do not know much of life, although many of them may have had a varied experience; few have the wise perspective that enables them properly to appraise their own abilities and position in the light of some definite objective. Nor do many of them either seek the advice of older individuals, or, if such advice be given, carefully consider it. They are for the most part like scraps of paper blown by the chance breezes, some flying high in triumphant swirls and others dragging in the gutters of the streets. Maturity does bring balance to the greater number and eventually life's experiences bring most of the others into line.

"Class spirit" is one of the influences that results in excessive activities of an inconsequential nature and requires large groups of students to conform to customs of doubtful value. It should be greatly modified. The customs and manners of individual students should be voluntary, not obligatory as they are in so many institutions.

The value of time is not sufficiently impressed upon college students. The student does not have sufficient freedom of choice in abstaining from useless activities. He is in the grip of a system that is as strong as some types of labor unions. The kind of "public opinion" that rules on certain college campuses is in need of reorganization upon a more liberal plan. The argument, not infrequently given, is that student activities give experience in executive work. So they do, but the argument is a weak one, for the number of students that can actually function in executive positions is inconsequential compared with the student enrollment.

To Him That Hath

WILLIAM WRIGLEY, Jr., owns Catalina Island, near Los Angeles, where he lives for odd moments in a palatial residence, and where he adds to an immense fortune made in the chewing-gum industry by catering for tourists and leasing the "atmosphere" for motion pictures. Another source of income is in the offing: A prospect hole put down in old diggings has disclosed rich ore. A third shipment, of 100 tons, was recently received at the Selby smelter of the American Smelting & Refining Co., on San Francisco Bay. Assays of former shipments have averaged about 88 oz. silver and 30 per cent lead per ton.

In a press interview, Wrigley exudes optimism. "Indications," he said, "are that it is going to be one of the biggest silver-lead mines in the world. Not only one but many veins are being opened up in the hills back of Avalon, and all are getting richer every foot of the way." The news is given without reserve; for here, at least, there is no need to solicit funds for development. But what chagrin for the Los Angeles promoter—a never-ending stream of tourists, each with a wad of savings; a "rich" mine, on a small island where and near by most of the marine scenes of filmdom are "shot." And all in the hands of an individual who pays the largest government tax in Chicago!

Silver Mine Superintendents From Utah

IF YOU OWN a promising silver mine and desire to get a manager who will make the most of it, you might do well to pick out a native of Utah. At any rate the wisdom of such a course is suggested by the fact that three of the outstanding silver mines in the world are in charge of men who were born, raised, and educated in Utah. These are the Bawdwin (meaning silver well) mine, of Burma Mines, Ltd.; the Premier mine, in British Columbia, controlled by the American Smelting & Refining Co.; and the Tintic Standard mine, at Eureka, Utah.

In the Bawdwin mine, according to its annual report just issued, 4,514,797 tons of ore is developed averaging 22.5 oz. of silver per ton, aggregating something more than 100,000,000 oz. of silver in addition to lead and zinc. A. R. Oberlander, whose father, now more than ninety years of age, still carries a bag of company mail from the Murray smelter, in Utah, to the A. S. & R. office in Salt Lake City every day, is general superintendent of the varied operations in Burma. Those who are conversant with the facts admit that A. R. Oberlander has done more than any other individual to put the Bawdwin mines on the map.

Everyone knows the short but thrilling career of the Premier bonzana, in British Columbia. Although

the company is styled "Gold Mining," the silver in the ore is of considerably more value than the gold. In three years, more than $6,000,000 has been distributed in dividends, and an extra Christmas dividend of 2c. per share has just been declared in addition to the regular disbursements of $1,600,000 a year. Although the measurable ore reserve in the Premier does not compare in size with that of the Burma property, current development is highly satisfactory and the mine is recognized as one of the world's leading silver properties. D. L. Pitt, born in Utah, and a graduate of the Utah School of Mines in 1907, became general manager of the Premier soon after control passed to the American Smelting & Refining Co., and to him, of course, belongs much of the credit for successfully conducting operations.

The Tintic Standard, another comparatively young mine, probably has the largest developed reserves of silver ore in North America. The company did not make public its reserves in its last annual report, but from trustworthy sources comes information that the blocked-out ore contains more than 25,000,000 oz. of silver. The company has paid dividends totaling $3,560,000 and has recently declared an extra Christmas dividend of 30c. per share, or a total of $350,000. Records for 1924 will show the company second to Anaconda as a producer of silver in the United States—and Anaconda has a score of mines. J. W. Wade, now assistant manager, has had direct charge of the mine and mill for the last four years. Indeed, when he assumed his present position the condition of the mine was bad; and the limits of the ore seemed to be in sight. To the assistant manager belongs most of the credit for successfully solving the geological and other technical and engineering problems. Mr. Wade, like Mr. Pitt, is a native of Utah and a graduate of the Utah School of Mines.

There are many ways in which to judge the greatness of silver mines; but the three we have mentioned are surely in the front rank of Company A in the crack regiment. Possibly, if the facts were ferreted out, it would be shown that New York or Illinois or California has produced more successful silver-mine managers than Utah. But the showing made for the intermountain state and its school of mines is certainly good. Perhaps living and learning in the leading silver-producing state of the Union is in some way a contributing cause.

How Diamonds Were Discovered in the Belgian Congo

ANY IMPORTANT DISCOVERY depends upon a chain of circumstances, the failure of any link in which would have prevented the event. This is emphasized in a recent number of *L'Illustration Congolaise*, which gives the story of the discovery of diamonds in the Congo, a discovery which has led to a great industry. Speaking of the company, the "Forminière" formed in 1916 by the Ryan-Guggenheim American group and the Belgian group of the Société Générale de Belgique, the account proceeds:

"The Forminière, according to the terms of the concession, had to make use of its rights of exploration over an immense territory in a limited number of years. It set to work without loss of time, since, in May, 1907, it sent to Africa its first prospecting party. Two years passed in exploration, years remarkable for their scientific results but not opening perspectives of an immediately profitable exploitation.

"However, at the end of 1909, a ray of hope illumined the horizon. One of the Belgian engineers of the Forminière, studying methodically, before the organization of a new expedition, the specimens gathered by the prospectors, identified a tiny diamond. After laborious research it was established, thanks to an entry in the notebook of the head of the party, an American engineer-geologist, that this diamond had been found in the concentrates of a panning made by a Belgian prospector near Mai-Munene near the Pogge (upper Kasai) Falls.

"A recent article leads us here to insert a parenthesis. Certain journals, under the influence of national pride, have said that the Belgian prospector had the credit for his discovery contested and had been treated with ingratitude by the Forminière. We have had it at heart to clear up this point, and this is what we have learned:

"The three persons mentioned in the press articles—M. Narcisse Janot, prospector; M. Millard King Shaler, American engineer-geologist, and M. Prosper Lancsweert, Belgian mining engineer, all still in the service of the Forminière, in different positions—have been troubled by the rumors put in circulation, and, guided by the interest for truth, and by a very legitimate pride, have desired to put the facts on the proper footing. To this end, they drew up on March 20, 1924, a statement which we have before us and from which we take the following extracts:

" 'The discovery of the first diamond of the Kasai is not, properly speaking, the "invention" of anybody. It is due to a chain of fortunate circumstances with which three names are associated. These are N. Janot, prospector; M. K. Shaler, American engineer-geologist; and P. Lancsweert, Belgian mining engineer. . . .

" 'In September, 1909, M. P. Lancsweert, examining at Brussels the specimens brought by this party (the first prospecting expedition), found in a little tube, among several minerals, a colorless crystal which he identified as a diamond. This identification was afterward confirmed by Professor Buttenbach, who was called in consultation.

" 'The tube did not have any label as to locality, but M. Janot, who helped in the examination, declared that the specimens must have been gathered by him in Maniema; that is to say, in the region of Tanganyika Lake.

" 'As M. Janot had been, during the expedition, under M. Shaler, recourse was had to the records of this engineer, through the chief of the party. Thanks to his notebook, extracts from which are given below, he showed that the diamond came from near Mai-Munene, in Kasai.

" 'Extracts from the field notebook of M. K. Shaler:

" ' "Monday, Nov. 4, 1907. Mai-Munene. This morning, Janot prospected the Kiminina Brook, about 300 meters past where the road cuts it. Here he found a color of gold in the gravel at a meter's depth. He could not continue his prospecting on account of the rain. The 'color' is larger than the others which we found at Pogge Falls; it has sharp edges and has not been carried far.

" ' "In the pan Janot found a little transparent gemstone, having a luster higher than the specimen of diamond in my collection, and having apparently the crystal form of diamond.

" ' "I am putting this stone aside for later examination, because we have not the means to determine the specific gravity and the stone is too small to determine its crystallographic properties with a hand lens.

" ' "In August, 1911, M. Janot, having been apprised of the extract from M. Shaler's notebook, left the Kwango, where he was to prospect, and proceeded to Kasai, at Bantua-Sanki, near Kabambaie, where he found several diamonds. . . .

" ' "If M. Janot had not collected this stone, if M. Shaler had not methodically noted the result of examination of concentrates made by him in Africa, if M. Lancsweert had not been extremely careful in the examination he made in Brussels, it is probable that for a long time yet the riches of the region of Kasai would have remained unknown." ' "

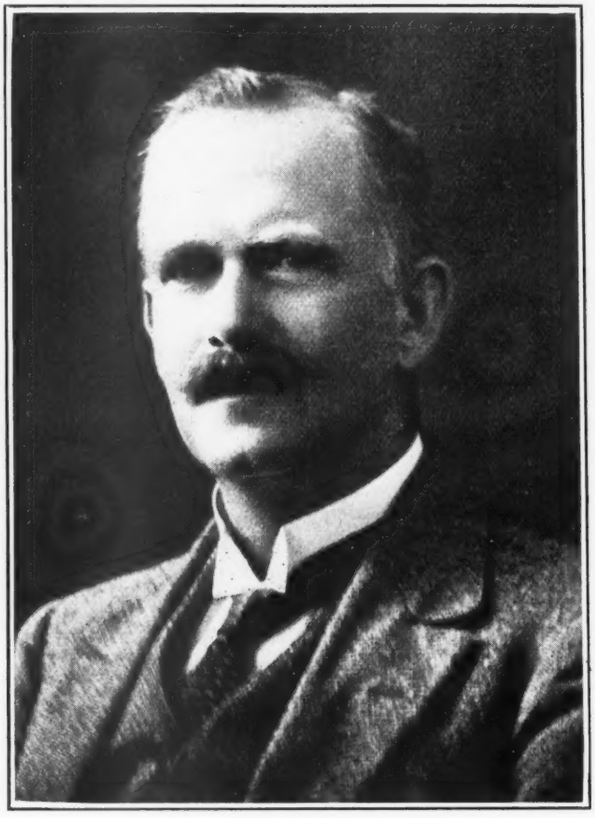
The diamond production of the Forminière, in this region, which production began with this little diamond, reached 240,000 carats in 1923.

This is an interesting story of a great mineral discovery, even if not so picturesque as the mines which were found through the chasing of a burro—as was Tonopah—or other delectable tales. Here is an account that shows the worth of planning and system in prospecting.

Metallurgists of Note

William Arthur Caldecott

THE successful operation of the cyanide process for the treatment of gold and silver ores initiated a new era in the field of industrial technology; and William Arthur Caldecott stands prominently among those identified with its introduction and early development — among a small group of enthusiastic scientists and engineers whose efforts and persistence served to demonstrate the practicability of the method, and thereby to contribute in large measure to what has since been recognized as a signal advance in the art of metallurgy. The great-grandson of an early settler in South Africa, Caldecott was born in Malta in 1869, educated in the Cape Colony, and was graduated in science from the Cape of Good Hope University in 1889. His initial work in the metallurgical field was as amalgamator with the Du Preez Gold Mining Co., in the Transvaal. In 1890 he entered the service of the Cassel Gold Extraction Co., as assistant chemist at the demonstration cyanide plant at the Salisbury mine, Johannesburg, which played so important a part in the introduction of the MacArthur-Forrest process in South Africa, and, later, throughout the world. In the same year, while still in the employ of the Cassel company, he was transferred to the Barberton district of the Transvaal, where he operated a plant to cyanide the tailing from the Fever Creek battery of the Sheba Gold Mining Co. In 1896 he gave expert evidence on behalf of the patentees in the suit brought against them by the president of the Transvaal Chamber of Mines. Between then and 1899 he was associated with the Rand Central Ore Reduction Co., under the management of Charles Butters, giving particular attention to research on general treatment methods of gold ores and the handling of accumulated slime. In 1907 he made a tour of North America to get first-hand knowledge of metallurgical practice in the recovery of gold and silver by the cyanide process in Canada, the United States, and Mexico. Between 1901 and 1923 he occupied the important position of consulting metallurgist to the Consolidated Goldfields of South Africa, Ltd., and was responsible in no small measure for the high standard of results in Rand metallurgical practice on a large scale, being an early exponent, *inter alia*, of the advantages of heavy stamps, coarse screening in the batteries followed by tube mills, and the finer grinding of banket ore. During this period he invented and introduced the "diaphragm" cone classifier and the sand filter table; and, in collaboration with several fellow workers on the subject, compiled "Rand Metallurgical Practice." In 1923 Dr. Caldecott was appointed Director of the Industries Division, and Technical Adviser of the Mines and Industries Department, of the Union of South Africa. To this post he brought an appreciation of the importance of economic considerations in technical work, evidenced by reports of commissions, of which he acted as chairman, on "Economic Policy for the Union" and the "Purchase of Government Supplies" published in the May, 1924, issue of that excellent monthly, the *South African Journal of Industries*, issued by the Mines Department. His versatility in subjects of inspiration is evidenced by an article published late in 1922 on investment, prompted by the belief that students should receive instruction in what he terms personal economics. The pursuit of riches as the worthiest of objectives is not implied, but rather an early attitude of foresight, and consistent adherence to a definite policy of provision against whatever periods of non-productiveness the future may have in store. Dr. Caldecott, to whom the highest degree in science was bestowed by the Cape of Good Hope University in 1909, has contributed much of commercial value and scientific inspiration to the literature of the milling and cyaniding of gold ore. His name may be found in the first volume (1894) of papers, discussions, and achievements of that enthusiastic group of pioneer cyaniders that formed the Chemical and Metallurgical Society of South Africa, and in the technical press of many countries and the transactions of European and American professional organizations. He is a Fellow of the Royal Society of South Africa, a medalist of the Institution of Mining and Metallurgy, and was president of the Chemical, Metallurgical and Mining Society of South Africa in 1904-05.



W. A. CALDECOTT

Ore Injection at the Cananea-Duluth Mine

Deposit Represents Viscous Solution Derived From Parent Magma Injected Into Broken Rock Along Fractures and Crystallized to Form a Cement

By Graham John Mitchell
Chief Geologist, Cananea Consolidated Copper Co.,
Cananea, Sonora, Mexico

ONE COULD hardly find a more interesting field for the study of ore deposition in its relation to igneous activity and structural deformation than that offered by the mineralized district of Cananea, Sonora, Mexico. The numerous rock clans—granite, syenite, granodiorite, diorite, and gabbro, with their varied phases, many of which are genetically related to ore—mark this region in the Cananea Mountains as a center of intense magmatic differentiation. Faulting and rock fracturing are pronounced and both have exerted a major controlling influence upon ore formation. The purpose of this paper is to show, using by way of illustration one striking type of deposit in the district, the dependence of ore deposition upon igneous intrusion and structural deformation.

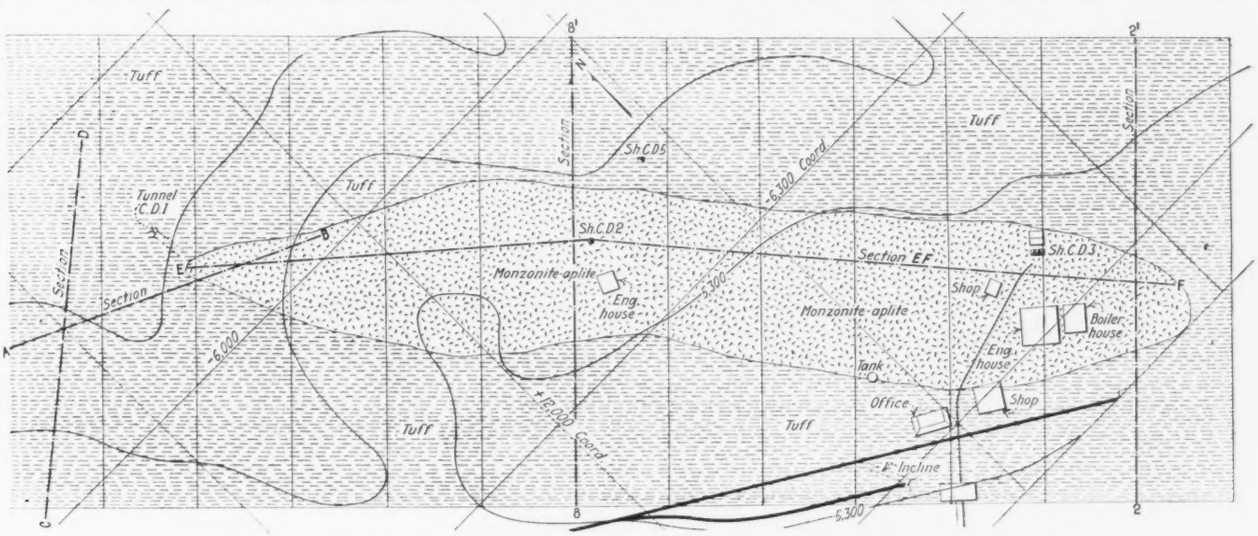


Fig. 1—Geological map of surface, showing outcrop of monzonite-aplite and tuff Locations of sections (Figs. 4, 5, 6, 7, 8) are indicated

The Cananea-Duluth mine is situated at the southeast end of a rectangular mineralized area which extends a distance of approximately six and one half miles with an average width of one and one half miles within the boundaries of which occur the principal mines of the Cananea Consolidated Copper Co. The accompanying map (Fig. 1) gives the surface geology of the mine and shows the elliptical form assumed by the outcrop of the monzonite-aplite, the longer axis of which trends northwest-southeast. In depth the intrusion widens, pitching southwesterly, with the northeast wall the steeper. At the surface it has a light yellowish color with iron stains along fractures and in casts of pyrite. The texture is very fine-grained, with an occasional quartz phenocryst. Microscopic examination places the rock with the fine-grained acid intrusives. It is made up of quartz and orthoclase with a little muscovite, these minerals interlocking to form a mosaic of roughly equidimensional grains. Sericite is developed from the feldspars and in part from quartz, with subsequent formation of kaolin. Pyrite is abundant in some slides, with zircon, titanite, and apatite present as accessories.

The magmatic history of this rock is revealed in the lower mine levels, where it is found grading into quartz-monzonite porphyry and monzonite porphyry. The monzonite porphyry contains andesine and orthoclase partly altered to sericite and calcite. When quartz is present as phenocrysts, the borders are rounded by corrosion. The groundmass of both the monzonite porphyry and quartz-monzonite porphyry is composed of a fine-grained aggregation of feldspars, much of which has been sericitized. In thin sections of the former rock are seen biotite phenocrysts, the cleavage lamellæ of which have been twisted and bent apart, allowing the quartz and pyrite to enter. Crystals of the latter have also developed around the mica. In brief, we have a monzonitic intrusion with quartz-monzonite and aplitic phases, the last of which forms the outcrop and is most extensive on the upper levels of the mine.

The tuff, through which the monzonite-aplite cuts, is both bedded and massive. Where bedding is present, the dip varies from 10 to 25 deg. northeasterly, with a northwesterly strike. The texture ranges from very fine-grained material to that in which fragments measuring several inches occur, these latter being both andesitic and trachytic in composition. The tuff is easily recognized except where metamorphosed at its contact with the intrusive. It is generally of either a greenish or reddish cast, the metamorphosed portions as a rule being of lighter hue. When blocks of the fine-grained tuff have been incorporated in the monzonite-aplite, as, for example, on the upper levels, they have been changed and resemble the inclosing igneous rock.

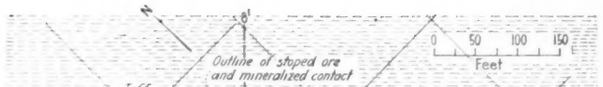


Fig. 2—Workings on 400 level, showing outline of stoped ore and mineralized contact

Metasomatic alteration is confined to the immediate contact, where it has developed pyrite and sericite, these minerals diminishing in quantity a short distance from the intrusion.

The dike-like habit of the monzonite-aplite shows that the intrusive found it easier to penetrate the tuff along a nearly vertical fracture or fractured zone than to follow bedding planes. The lack of violence during intrusion is evidenced by the absence of marked disturbances in the surrounding tuff, the only structural effect upon this formation being a slight arching of the adjacent beds. The aplite, however, underwent fracturing at the contact, producing a network of cross-cutting planes which broke the rock into blocks of varying sizes. In places the tension during cooling was partly relieved by cracking which was directed irregularly toward the center of the igneous core. This feature is best seen on the 100 and 200 levels and is less pronounced in depth.

The most intricate breaking took place at the contact encircling the elliptical mass and extended down along its walls with varying intensity both laterally and vertically. The mineralized "breccia" at the northwest and southeast ends, where ore extends from above the 100 to the 800 level, the lowest point reached by development, illustrates the continuity and intensity of fracturing at these pointed extremities. The fracturing, as will be subsequently shown, has exerted a major controlling influence on primary ore deposition.

The primary sulphides, tetrahedrite, sphalerite, pyrite, chalcopyrite, galena, and argentite, in conjunction with a gangue composed chiefly of quartz with some siderite and adularia, act as a cement binding together angular fragments of the monzonite-aplite and to a less extent fill fractures in it (Fig. 10). Included blocks of tuff in the igneous rock are mineralized along the bedding planes and in narrow fractures. Except for a very limited distance (a few feet) in the metasomatically altered tuff at its immediate contact with the monzonite-aplite, the ore does not occur in the fragmental volcanic material.

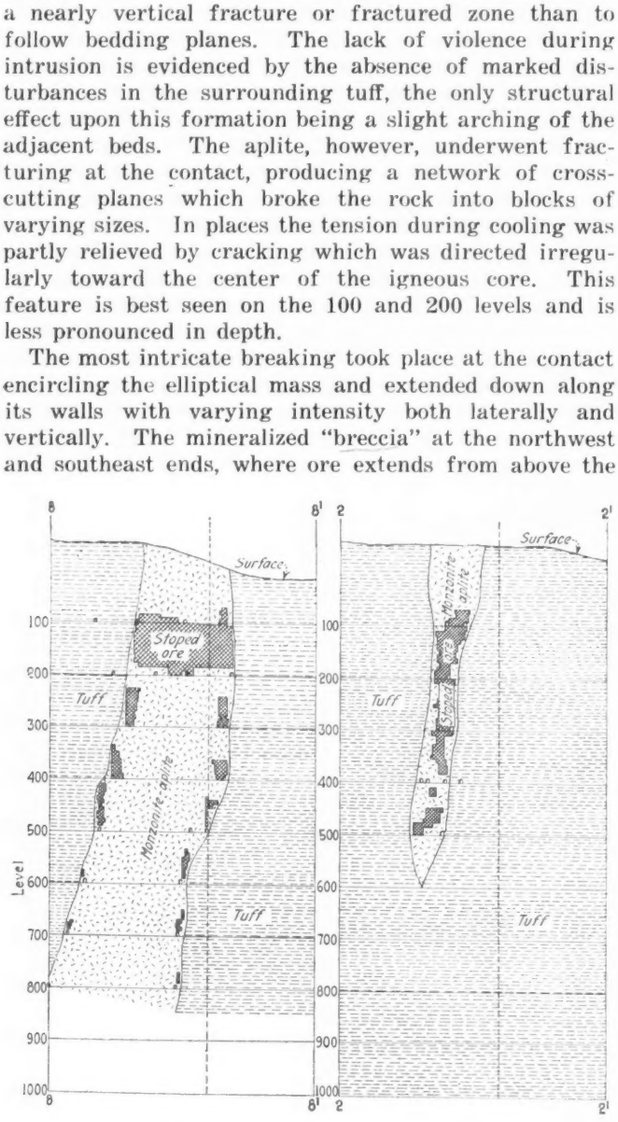


Fig. 4 Fig. 3

Fig. 3—Section 2-2′ through southeast end ore pipe. Fig. 4—Section 8-8′ through central portion of mine, showing relation of ore to contact of monzonite-aplite and tuff; also wider distribution of ore above the 200 level in this section of the mine

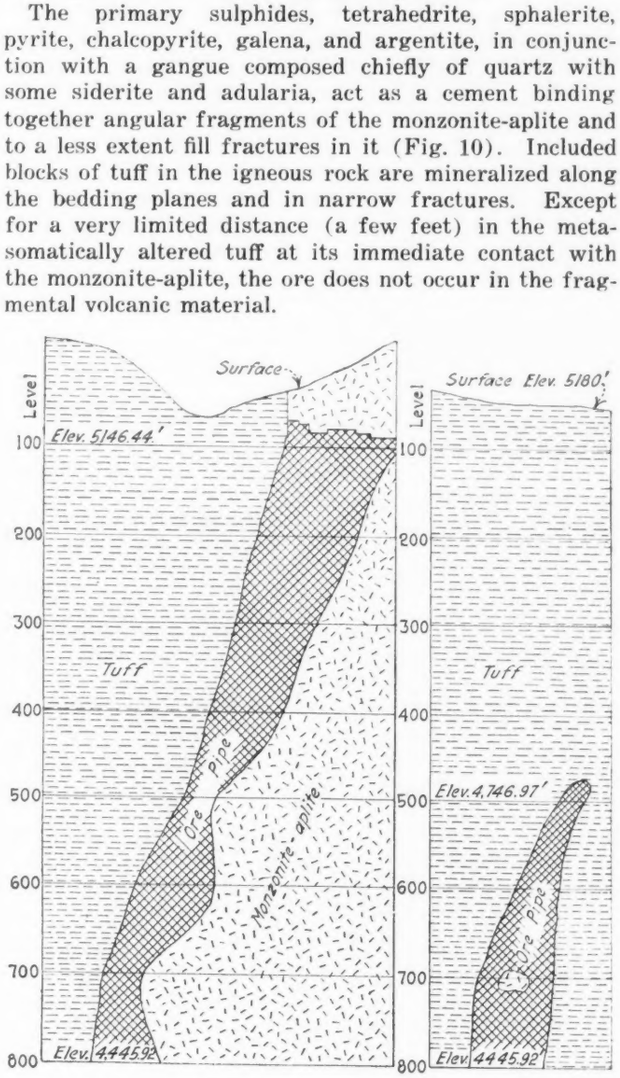


Fig. 5 Fig. 6

Fig. 5—Section A-B through ore pipe at northwest end of mine (Fig. 1). Fig. 6—Section C-D through ore pipe at northwest end of mine

The order in which the sulphides were deposited overlap. Tetrahedrite, the most abundant of the commercially important primary minerals in the ore thus far developed, occurs among the first and last formed, being found in some instances intercrystallized with the earliest filling in the cement and continuing to appear among the quartz until a central cavity is reached, where it fills the voids between inpointing quartz prisms. Crystals with tetrahedron faces measuring as much as one inch along the edges have developed. Upon one such face a small group of radiating quartz has grown. Pyrite and chalcopyrite also appear among the first and last to form, being found both as microscopic inclusions in tetrahedrite and intergrown with the other sulphides in the massive ore. They also form crystals held in place by clusters of quartz in the centers of cavities. The range of sphalerite and galena

is the same as that of pyrite and chalcopyrite. In the case of galena, one group of cubical and octahedral crystals found in a cavity had good octahedral cleavage developed in the octahedrons. Argentite was apparently among the last minerals to be developed, as only a single small mass of crystals was found occupying a vug in the other sulphides.

Quartz is the prevailing gangue, in places comprising almost the entire cement with only occasional included specks of the sulphides. It is intercrystallized with the ore minerals, growing from the faces of the angular rock fragments in comb and massive fashion and forming also the walls of numerous small cavities occurring in the monzonite and monzonite-aplite and in the cement around blocks of the latter. It appears too as veinlets cutting the igneous material. Paragenetically it ranges throughout the entire period of ore formation. Other gangue minerals are siderite and adularia. Both of these are found as groups of well-formed crystals growing in quartz-lined vugs in the ore, the siderite also forming in the branching forks and along the sides of quartz crystals.

As previously stated, the ore occurs as a cement around angular fragments of the monzonite-aplite and to a minor degree fills fractures extending into the igneous rock. The most pronounced fracturing and subsequent mineralization are confined to the periphery of the intrusive, having had little effect upon the intruded tuff. Where included blocks of tuff have been mineralized, the ore follows bedding planes and joints, with only slight impregnations of the rock fragments (Fig. 9). The mode of occurrence is one of filling, and the question arises as to the manner in which this process operated. Was it replacement by heated solutions which, following fractures bounding the broken blocks, gradually substituted their metallic and non-metallic content for a part of these blocks and finally consolidated to form the ore? Or have we here an example of what has been recently propounded by J. E. Spurr[1]—namely, the injection of a viscous ore solution into fractured portions of the rock mass, the solution forcing its way along cracks and later consolidating and acting as a cement?

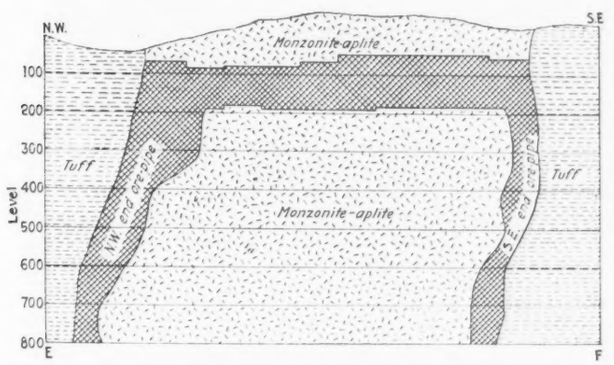


Fig. 7—Section E-F (Fig. 1) along longer axis of intrusive, showing relation of ore pipes to blanket-like deposit above 200 level

If we examine the walls between ore and waste, we find a sharp line marking their contact. They indicate filling without replacement, the blocks apparently having been forced apart. The rock fragments have not been eaten into as in cases where replacement has been active. Banding is absent, the prevalent structural relation of the sulphides and gangue being massive and interlocking. If replacement does not account for the place occupied by ore, some force has, however, pushed the blocks apart to the extent now represented by the cement. That growing crystals do exert pressure is true. Evidence of this in the case under discussion can be seen in Fig. 9. The rock is trachytic tuff from the immediate contact with the monzonite-aplite. The pyrite crystal has made a place for itself in the orthoclase by forcing a segment of the latter aside. When one crystal can accomplish this result, it is logical to believe that others can exert a similar action. Thus we could attribute to growing crystals a part of the force necessary to provide openings for ore. Some inherent pressure, however, such as that exerted by magmatic gases, is necessary to bring the solutions to the point where crystallization is initiated. In Fig. 9, the cemented blocks have the appearance of loose fragments suspended in a pasty mass without much previous jostling about. The large piece at the right has apparently settled down to its present position, the edge of the underlying block having acted as a fulcrum. The conditions illustrated by Fig. 9 are not in harmony with replacement processes.

Fig. 8—Micro-drawing of metosomatically altered trachyte fragment (Tr.) in tuff at contact with monzonite-aplite. Pyrite crystal (P) has displaced the segment of orthoclase (Or.) Mag. 75X

There is a certain analogy between this ore filling and a case of a 10-in. vein of enstatite (Fig. 11) which cuts peridotite, the pyroxene having penetrated the inclosing rock along a fracture.[2] If this vein had also contained olivine as an essential primary mineral, it would be classified as a peridotite dike and would be considered the result of igneous intrusion.

Closely associated with the ore, in some instances connected with the sulphide cement by small veinlets of quartz, are irregular patches of coarse-grained material, 10 in. or more across, filling spaces between fractured

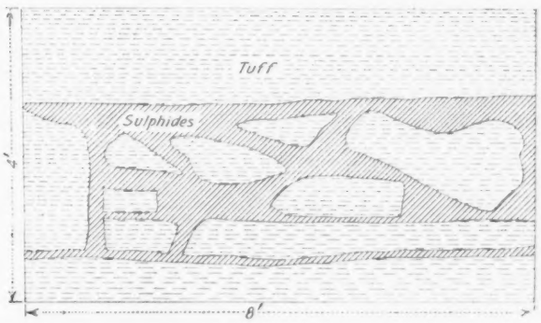


Fig. 9—Sketch of ore occurrence on 200 level, showing sulphides cementing dislodged blocks of tuff and also acting as a filling along the bedding planes of this rock

[1]Spurr, J. E.: "The Ore Magmas." McGraw-Hill Book Co., 1923.

[2]Butler, G. M., and Mitchell, G. J.; Bulletin, Oregon Bureau Mines and Geology, Vol. 2, No. 2, p. 32, Fig. 16, 1915.

Fig. 10—Details of mineralized contact on 700 level

Vertical section looking northwest along the aplite-tuff contact. Note the sharp contact of ore and tuff; also sulphides filling fractures extending into the aplite wall on the left.

blocks of the monzonite-aplite. They convey at first glance the impression of foreign inclusions, but closer examination proves them to be genetically related to the inclosing rock. They are made up of quartz and orthoclase with varying quantities of the sulphides, chiefly pyrite. When examined microscopically, a fluxion structure is seen in the arrangement of the quartz and orthoclase, among the crystals of which occur pyrite, tetrahedrite, and sphalerite. The sulphides are generally in the central part of these patches where they line the edges of minute vugs. Well-formed crystals of zircon are also present. These occurences are interpreted as products of differentiation of the parent magma, and, were their sulphide content increased, they would be indistinguishable from ore. They are comparable to pegmatite in that they represent a coarse-grained, siliceous differentiate injected into the consolidated and fractured monzonite-aplite. The analogy between their formation and that of the ore is significant. The Cananea-Duluth deposit represents, then, a viscous ore solution derived from a parent magma which has been injected into broken rock along fractures and, pushing the rock fragments apart, has crystallized to form a cement.

Relation of Ore to Rocks and Structure

A study of the accompanying maps and sections emphasizes the relation of ore to the rocks and structural features. Fig. 2 is a plan of workings on the 400 level. The peripheral arrangement of mineralization, its sharp contact with tuff and its concentration at the ends are shown. Fig. 4 shows the vertical arrangement along the side walls and the controlling influence of the fractured contact of igneous rock in directing the course of the ore solutions, stopes following with fidelity the broken material. The two ore pipes, one at either end of the mine, further illustrate this feature, the concentrated fracturing at the pointed extremities of the intrusive having had much to do with the formation of these chimney-like orebodies. Above the 200 level (see Fig. 9) included blocks of tuff lying in a nearly flat position have been cemented by sulphides and impregnated with these minerals. Flat dipping fractures

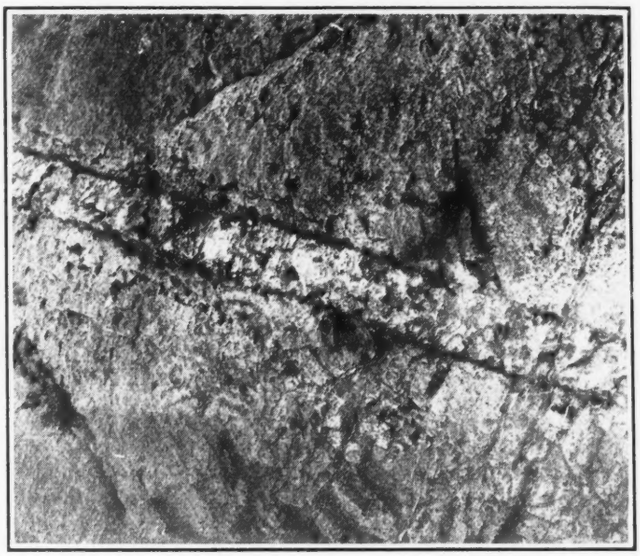


Fig. 11—Ten-inch vein of enstatite in peridotite, Collier Creek, Curry County, Oregon. Photograph by G. M. Butler

filled with ore are also more common in this part of the mine. These features, together with enrichment by chalcocite, tenorite, and covellite, have resulted in a wider horizontal distribution of ore occurrence at this elevation.

Structure of Electro-deposited Metal

R. Audubert recently published an article in *Revue de Métallurgie* (1924, No. 21, pp. 567-584) on the structure of electro-chemical deposits. According to an abstract in *Chemistry and Industry*, four classifications of deposits are made by the author, depending largely upon whether the rate of formation of new crystals is greater or less than the rate of growth of those formed already. When these values are about equal a fine-grained homogenous structure is obtained.

The structure of deposits depends on the nature of the metal deposited and the conditions of electrolysis; copper, bismuth, antimony, zinc, cobalt, and nickel tend to form fine-grained deposits, and silver, lead, thallium, and tin in ordinary solutions of their salts deposit in large crystals, so that more complicated electrolytes—cyanide solutions—are used. Lead, silver, and cadmium deposit in fine grains from a solution of their fluosilicates and also from a perchlorate solution. The general good effect resulting from the presence of either organic or metallic colloids in the electrolytic bath is attributed to the colloid retarding the rate of growth of the deposited crystals. Up to a certain maximum value beyond which the crystals become pulverulent, increase in current density favors a fine structure in the deposit.

How Hargraves Found the Gold

The Story of the Discovery of the Precious Metal in Australia by a Miner from California

By T. A. Rickard

IT IS NOT GENERALLY KNOWN that the man who discovered gold in Australia wrote the story of his adventure, although many of us are aware that his name was Hargraves and that he had been helped in his prospecting by previous experience in California. His account takes the form of a small book published in London in 1855, at which time he, Edward Hammond Hargraves, was living there. A copy of the book, inscribed with the author's signature, was given by him to W. P. Moffat in 1855, and from him it passed to his son, M. C. Moffat, who gave it, in 1866, while in San Francisco, to Gregory Yale, the father of Charles G. Yale, of the U. S. Geological Survey. Mr. Yale lent it to me. It fulfills every expectation; for it is a frank and intelligent description of what Hargraves saw in California, and states how he was led, from his observations in the Sierra Nevada, to infer that extensive gold fields existed likewise in his own country, New South Wales.

Hargraves was born at Gosport, near Portsmouth, England, in 1810. At the age of fourteen he went to sea, and remained in the mercantile marine for three years, during which time he traveled widely, and, presumably, sharpened his powers of observation. When seventeen years old he became a settler, or squatter, in Australia. At eighteen he married, and at nineteen he was a father; so he may be said to have assumed manly responsibilities at an early age. He was industrious and frugal; he worked hard on what we would call a ranch; but he made scarcely any money, and suffered with others in the general bankruptcy that overwhelmed New South Wales in the years from 1841 to 1843. In 1849 the news reached Sydney that gold had been found in California and that one could become rich there in a short time. A vessel arrived with 1,200 oz. on board. That started the stampede. Hargraves was then thirty-nine years old. He sailed in July and reached San Francisco after a passage of seventy-eight days, in October, 1849. The history of Australia is linked with that of the United States by two events. When the American colonies revolted, and convicts could be sent no longer to Virginia and the Carolinas, the British Government decided to make use of Australia for that purpose. The western coast of Africa was tried, but it proved unsatisfactory. Thereupon, a convict settlement was established on the shore of Botany Bay, near Sydney, in 1787. The finding of gold in California led to the development of gold fields in Australia; and that put an end to the sending of convicts to Australia. The land of the Southern Cross, ceasing to be a convict station, became an industrial commonwealth.

Upon his arrival in California, Hargraves, with seven others, went to Stockton, and thence to the diggings near Jamestown, in Tuolumne County. The diggings at Jamestown were on Wood's Creek, to which came the drainage from Yankee Hill and Bald Mountain, on both of which pocket mines were developed later along the numerous quartz veins that traverse the slate. At once this Australian noted the similarity between the conditions under which the gold was being found in California and those he knew to exist in New South Wales. He says: "My attention was naturally drawn to the form and geological structure of the surrounding country, and it soon struck me that I had, some eighteen years before, traveled through a country very similar to the one I was now in, in New South Wales. I said to myself, there are the same class of rocks, slates, quartz, granite, red soil, and everything else that appears necessary to constitute a gold field. So convinced did I become of the similarity of the two countries that I mentioned my persuasion to my friend Davison, and expressed my belief that we should soon hear of a discovery of gold in that country, and my determination, if it was not discovered before my return to New South Wales, to prosecute a systematic search for it." His friend Simpson Davison was by way of being a geologist and a metallurgist, but his views on the origin of gold deposits, given in the appendix to the book, indicate that his knowledge was shallower than the average placer mine. Among the companions of Hargraves were some who raised the objection, he says, "that many professed geologists had traveled over the country to which I referred; and that if it was auriferous they must necessarily have discovered it. But I knew how different scientific knowledge was to [from] practical experience." At that time, of course, geology was in its infancy, and the science of ore deposits was non-existent.

Even today the geologist cannot predicate the occurrence of gold in any locality merely on the existence of certain kinds of rock; the "slate, quartz, granite, and red soil," to which Hargraves refers as the signs of a gold field, are not everywhere the companions of gold. They are found in places where gold is lacking. Besides, the question is one of economics; to become the basis for profitable mining the gold must be present in a proportion larger than that which would suffice merely to establish the geologist's contention that it was to be found there. The determination of the existence of gold in profitable amount is to be made not by geologic observation alone, but by the investigation of a prospector or an engineer. The test is based upon practical experience.

Panned $20 Per Day

Meanwhile Hargraves and his friends went to work at the diggings, and made some money—but not much. "Our earnings," he states, "never exceeded one ounce per diem, or fell short of five dollars' worth, after our experimental trial." Winter approached, and they suffered from the cold. In spring the partnership expired, and the group scattered. Hargraves describes the local geologic conditions thus: "The digging ground was composed of slates traversed frequently by trap dikes and quartz veins, which generally ran north and south. We worked for gold in the drift overlaying the slates, and also found gold in the

laminæ of these rocks; the largest deposits commonly rested in the indentations and cavities of the slates. In some localities, the gold was found evenly distributed through the soil from the surface downward—so even, indeed, that one could calculate to a nicety the produce of any given quantity of drift. In other localities the rock was not struck for twenty feet, and no gold was to be found at or near the surface; perhaps not until one got to within two or three inches of the bedrock." This is an intelligent description, and indicates that Hargraves was a competent observer, if, indeed, these notes were such as he made at the time, and not when he became more informed on the subject. In March, 1850, he went to San Francisco, and while there he wrote to a friend at Sydney, to whom he said: "I am very forcibly impressed that I have been in a gold region in New South Wales, within 300 miles of Sydney; and unless you knew how to find it you might live for a century in the region and know nothing of its existence." Here "it" must mean "gold." This letter was preserved by his correspondent, and served to substantiate the claims that Hargraves made later as the discoverer.

Hargraves and Davison decided to go to the "northern" diggings, so they proceeded to Sacramento, and thence to Marysville, on the Yuba. Hargraves visited Sutter's Fort, and states that James W. Marshall, the discoverer of gold in California, was "a person from New South Wales," although we know that he was a native of New Jersey. In June, 1850, Hargraves and his partner made 2½ oz. of gold per day in the diggings on the Yuba. But he was eager to test his idea about gold in his own country; "the greater our success was," he says, "the more anxious did I become to put my own persuasion to the test, of the existence of gold in New South Wales." In November he sailed from San Francisco, arriving in Sydney in January, 1851. Upon his return home, Hargraves lost no time in starting on his prospecting expedition. On Feb. 5 he set out on horseback for the interior. He crossed the Blue Mountains and reached Bathurst, from which town he decided to go to Guyong, where he had been eighteen years earlier.

On Feb. 10 he reached his destination and found quarters at an inn kept by a Mrs. Lister, to whom and to whose son he confided the purpose of his quest. The son, a boy of eighteen, provided him with a pick, a trowel, and a tinplate dish. After a day's rest he and young Lister went down Lewes Ponds Creek, which flows into the Macquarie River. After traveling 15 miles, he arrived in the locality that he was so anxious to reach. "My recollection of it," he says, "had not deceived me. The resemblance of its formation to that of California could not be doubted or mistaken. I felt myself surrounded by gold; and with tremulous anxiety panted for the moment of trial, when my magician's wand should transform this trackless wilderness into a region of countless wealth." But there was no water. There had been a drought that summer, and all the creeks were dry. Young Lister told him that lower down some water would be found. They dismounted, and ate some food before making the "grand experiment." The boy brought some water to drink, and, when their meal was finished, Hargraves set to work. He describes the discovery in these words: "I took the pick and scratched the gravel off a schistose dike, which ran across the creek at right angles with its side; and, with the trowel, I dug a panful of earth, which I washed in the water-hole. The first trial produced a little piece of gold. 'Here it is!' I exclaimed; and I then washed five panfuls in succession, obtaining gold from all but one." He says he was greatly excited, and gave relief to his overwrought feelings by exclaiming to his companion: "This is a memorable day in the history of New South Wales. I shall be a baronet, you will be knighted, and my old horse will be stuffed, put in a glass case, and sent to the British Museum!"

He did not lose his head, however. On his return that night to Guyong, he made a memorandum of the discovery, which later he handed to the Colonial Secretary. To ascertain the extent of the gold-bearing district, he went to the Macquarie River, 80 miles distant. Then he followed the river bed, along which a small stream was running, and examined its banks, which consisted of "compact schists, traversed by quartz veins, threads, and trap dikes." He panned the gravel, and found gold. After seven or eight days spent in this way he came to the conclusion that there was "at least 70 miles of auriferous land" in the part of the country he had traversed.

He told others about it, showed them how to prospect, and thereby caused gold to be found in other localities within a few days. His chief anxiety now was "lest some miner from California should make a similar discovery" and forestall him in his legitimate claim for a reward from the government. He hastened to Sydney, to tell the Colonial Secretary all about his successful investigations, and exhibited the gold in proof of his assertions. The Secretary was sceptical; he remarked: "If this is a gold country, Mr. Hargraves, it will stop the home government from sending any more convicts, and prevent immigration to California; but it comes on us like a clap of thunder, and we are scarcely prepared to credit it."

Hargraves addressed a letter to the Colonial Secretary, E. Deas Thomson, and asked for a bonus of £500 at once, in return for which he could disclose to officers of the government the places where he had found the gold, leaving the matter of further reward to be determined in accordance with the importance of the results that ensued. These terms were accepted.

Hargraves then proceeded to draw public attention to the discovery, but he made no effort to peg any claims for himself; "my only desire," he says, "was to make the discovery, and rely on the government and the country for my reward." Fortunately, he was not fooled; the Governor at once appointed him Commissioner of Crown Lands "at the usual pay of 20s. per diem"; later the Legislative Council of New South Wales awarded him the sum of £10,000. This appears to have satisfied him, for it sufficed to keep him in comfortable circumstances. Evidently he was more fortunate than James W. Marshall, for the discoverer of gold in California profited but little from his happy chance; he won a fictitious fame, it is true, from the finding of the gold, "which he had taken no pains to find, and which somebody must eventually have found very soon," as Josiah Royce says; and when he died a few years ago his biographers had to confess that after he picked up the nuggets in the millrace at Coloma he did little more than "prove himself thenceforth an utterly incapable man." He died impecunious and disappointed. Hargraves, after his intelligent discovery, enjoyed a comfortable and dignified life, maintaining a curiously philosophic detachment from the speculative activities that he had brought into being.

The Oil Resurrection of Colorado

Recent Discoveries Give Promise of Making State an Important Producer

By H. A. Wheeler
Consulting Mining Engineer, St. Louis, Mo.

EXCEPT for a few oil operators, it is not generally known that Colorado is one of the oldest of the oil-producing states. It is entitled to veneration and is to be classed as an antique when compared with California, Kansas, Texas, Oklahoma, Louisiana and Illinois, and Wyoming, Arkansas and Montana are mere youths in comparison. Yet when the huge gasser was brought in last fall on the Wellington dome, in northern Colorado, and soon afterward the big gusher on the Hamilton dome, in the northwestern part of the state, the public thought that a new producer had been added to the fifteen important oil states; but Colorado produced oil three years after Colonel Drake brought in the first oil well, or since 1862, from the Florence field near Pueblo, on the eastern flank of the Rocky Mountains. As the Florence field is shallow, the wells were small, coming in at 10 to 200 bbl. from the Pierre shale at depths of 1,000 to 2,500 ft., and the oil has a gravity of 32. It has been utilized by local refineries, and the total production to date aggregates about 11,000,000 bbl. During its fifteen best years, or from 1893 to 1908, the daily output ranged from 1,000 to 1,250 bbl., which at that period was a noteworthy production for an old field.

More than 800 wells have been drilled, and recently an extension of the field was found that came in with 200-bbl. wells. Like most shale wells, they are erratic and unually short lived, but one well (No. 49 of the United Oil Co.) has the remarkable record of pumping 619,834 bbl. since it came in as a 200-bbl. well at 1,955 ft. in 1890 until abandoned in 1913, after being deepened twice (to 2,480 ft.). The field has been very "spotty," dry holes occurring amid producers, and perhaps half of the wells drilled produced more or less oil.

In 1901 the Boulder field was discovered, which is only three miles from the eastern flank of the Rocky Mountains, and 30 miles northwest of Denver. Like the Florence field, the oil was found to be of erratic occurrence, small wells in the Pierre shale at depths ranging from 700 to 2,300 ft. Production was of very high grade, or 42 gravity, and 187 wells were drilled, of which about 20 per cent were commercial producers. About 39,000 bbl. was produced in 1903, the zenith year, after which there was a rapid decline. Seven wells are still producing from two to seven barrels per well.

Beyond some small shallow wells that were later found at Rangely and Debeque, on the west side of the state near the Utah line, Colorado failed until November, 1923, to furnish evidence of becoming an important oil producer in the occasional wildcat wells that have been drilled more or less freely throughout the state since the Boulder fiasco twenty years ago. A few geologists never lost faith in the future of Colorado, as the evidence of several untested structures was highly favorable. Among the most persistent of these optimists was Dr. R. D. George, the State Geologist, who early pioneer work on encouraging structures has since proved very valuable, although received with frigidity by the oil fraternity at the time it was executed. A dry hole nearly 4,000 ft. deep drilled by the Poudre Oil & Gas Co. in T. 31, R. 9, S. 68, on a location supposedly recommended by Dr. George in 1916, was regarded as fatal to the Wellington dome, on which it was located, as well as to Dr. George's reputation, until it developed that the location recommended was in T. 31, R. 10, S. 68, or 6 miles further north, and it is on the latter section that the initial discovery well was brought in.

Geological Examinations in the Wellington District

In 1917 the Roxana company sent a number of geologists into the Wellington district, and they produced, at a cost of $35,000, a carefully executed structure map that showed three closed domes. On this encouraging evidence, which confirmed Dr. George's work in 1908, the Roxana company leased a large block of land in 1919 and drilled a well more than 1,300 ft. deep, but as only a little oil was found in the Hygiene sand, the well was abandoned and the leases were canceled, although the company's geologists recommended exploration at much greater depths.

Wellington Field—With the excellent Roxana structure map as a basis, Wyoming and local interests later leased a large block on all three domes and subsequently tried to interest the larger oil companies to drill it for acreage. About forty companies are said to have refused to consider it until the Union Oil Co. of California was approached, as the promising sands were estimated to be 4,000 to 4,500 ft. deep. After the geologists of the Union company checked up the structure and reported favorably, the interests above mentioned took over the leases and started a well on S. 31, T. 10 N., R. 68 W., which is the location which was recommended by the State Geologist several years previously. This well tapped the sand on Nov. 11, 1923, at 4,285 ft. and blew into a gasser that gaged 82,000,000 ft. per twenty-four hours, with a rock pressure of 1,400 lb. The gas was dry at first, but after blowing wild for forty days (while putting in concrete anchor and special heavy fittings), it produced considerable oil that "painted" the country for miles.

Vindication of Scientific Prospecting Methods

The bringing in of this huge gasser, with its subsequent liberal production of high-grade oil, not only vindicated the geologists but convinced intelligent oil operators that Colorado had a brilliant future in the "Dakota" sands. They realized that much of the previous wildcatting had been hopeless because it was not on structure, or else had not been drilled sufficiently deep to reach the rich Dakota horizon.

A mild boom followed the discovery of this Wellington gasser, and the country was leased for miles around the mapped structures. Though some leases subsequently changed hands, the market soon went stale, as either drilling contracts were insisted upon, or the first lessees demanded excessive royalties. A large part of the land was also formerly included within the Union Pacific R.R. grant, on which the mineral rights had usually been

reserved and the railroad company insisted on active operation and a 12.5 per cent royalty, in addition to a further royalty of 2 to 3 per cent to the surface owner.

Several wells were started by local stock companies on what is regarded as edge locations, but as they depend on selling stock at ½c. to 1c. a share (a Colorado fashion) they are making slow headway, as only high-powered sales agents can raise $100,000 at 1c. a share.

The Union Oil Co. started four wells last spring, of which two are on the Wellington dome; another on the Fort Collins dome is 10 miles south of the discovery gasser, and another is 6 miles southwest on the Douglas Lake dome. Two of these have been completed, of which the Mitchell well, a mile southeast of the discovery well, came in at 4,216 ft. as a 100,000,000-ft. gasser, with some oil, and the Whitaker well, on the Fort Collins dome, came in at 4,475 ft. as a very large oil well. Until tankage has been erected to provide for the latter, it is impossible to estimate its size, but it has been rated as a 10,000-bbl. well when drilled in, by competent authority. The bringing in of this oil well has started a new boom, and leases are rapidly advancing. Several wells are drilling and a number of locations have been made, and the Union company has ordered more rigs.

Possibilities of Larimer County Field

The original geological maps made three separate structures of this Larimer County field, and the Union company (of California) controlled almost the entire area within the closing contours of these structures, aggregating more than 12,000 acres. Later work by other geologists now indicates that it is one huge pool about 15 miles long north and south (parallel with mountains) with a width of 2 to 5 miles. If this latter opinion is correct, it promises to be the *"Salt Creek of Colorado,"* and it is probable that within the next five years it will not only equal Wyoming's famous Salt Creek pool, but may approach Cushing's record, which had a peak of 350,000 and when twelve years old is producing 24,000 bbl. a day.

At present, in common with all new fields, it is lacking in pipe lines, supply stores, competitive contractors, casing and shooting crews, and similar important operating conveniences, but these will undoubtedly make their appearance in 1925. As the rocks through which exploratory work must be done are mostly shale, with few hard-rock or water-bearing horizons and no red rock and no under-reaming required, drilling costs should finally recede to about $3 a foot, and the present costs of $60,000 to $90,000 a well should be cut in half. The Burlington R.R. skirts the eastern side of the field, with a branch to Waverly that cuts through the central part, and the Union Pacific R.R. has just completed an 18-mile spur along the western side. The attractive town of Fort Collins, with a population of about 10,000, is immediately south of the field. Fort Collins has two good hotels and excellent banking facilities. The surrounding country is rich agricultural land that is mainly devoted to sugar beets and is liberally supplied with irrigating ditches and reservoirs.

Union Pacific R.R. May Build Into Northwestern Part of State

Hamilton Dome.—About the same time that the Union company began drilling near Fort Collins, the Texas company started a well (June 21, 1923), near Craig, in Routt County, in the northwestern part of the state. It was located on a strong closed structure known as the Hamilton dome, and its objective was the same "Dakota" sand. About 100 bbl. of oil was found in the shale at 2,035 ft., and on March 3, 1924, the Dakota sand was struck at 3,820 ft. The well came in with 4,800 bbl. of 41 gravity oil. Very little gas occurs, and the oil yields 37 per cent of gasoline on straight run. As there was no tankage, the well was shut in until July, by which time a pipe line 22 miles long was laid to Craig, where a tank farm has been erected. When the well was reopened, it showed little injury from its long shut-in, and it produced 27,000 bbl. the first week. The oil is now being shipped out by tank cars to Florence, Colo., and Parco, Wyo., over the Denver & Salt Lake (or "Moffat") R.R. The latter is the only inlet into northwestern Colorado, and as it has to climb over two of the highest ranges of the Rocky Mountains, it is severely crippled by snow blockades in the winter. Though a tunnel has been started that will eliminate climbing a pass more than 11,600 ft. above sea level, it may be three years or more before it is completed, and until then winter shipments will be uncertain. However, if this region develops into a large producer, as now seems highly probable, it is probable that the Union Pacific R.R. will build a 125-mile branch from its main line at Wamsutta to Craig. As this will pass through a valley country of moderate altitudes (6,000 to 7,500 ft.) and have no high mountains to cross, it will have no serious trouble with snow to overcome.

Hamilton Gusher Starts Boom

The New Oil Era.—The bringing in of the Hamilton gusher marks a second era in the oil history of Colorado that promises to eclipse in marked degree its early pioneer record. It also has demonstrated that the Dakota sand is not only oil bearing, but unusually rich. Though the earlier Wellington gasser at Fort Collins satisfied the geologists and experienced oil operators that Colorado was destined for a brilliant career as an important oil producer, it was not convincing to the public until the Hamilton well filled a 5,000-bbl. tank in about twenty-four hours. This immediately started a state-wide investigation by the wide-awake oil operators in searching for geologic structures and possible new pools. The larger companies promptly secured offices in Denver and sent geological parties to search for domes and anticlines. In probably no state has the value and aid of the geologist been more keenly appreciated by oil operators in seeking leases on structure intelligently.

The mining brokers and promoters in Denver, who had been left stranded by the decadence of the mining industry, immediately began to organize drilling, royalty, and leasing companies. Though there was considerable activity in the sale of leases, the popular market was the sale of royalties, which were subdivided into such small fractions as to be within the reach of the most modest investor. The local press grasped the opportunity to start an oil boom that has resulted in an activity and interest in oil matters that has developed into a boomlet. At least the boom thus far is very modest and mild compared to the booming booms of Beaumont, Ranger, and Los Angeles, although later a much higher pressure may develop.

Lease prices thus far are moderate, but usually cover large tracts and are likely to carry drilling contracts, or else over-riding royalties, and as the 4,000-ft. wells at present cost about $75,000, the small operator is not an

important factor. Inside leases on good but unproved structures range from $20 to $100 an acre, with a royalty of 12½ to 17½ per cent; on proved structures, the prices are much higher—from $100 to $500. One inside lease on the Wellington dome after the first gasser came in sold for $1,500 an acre, which was cheap considering the great promise of this field.

Formations in Northwestern Part of State Favor Quick Drilling

Craig District.—The Hamilton well naturally concentrated attention on the northwestern part of the state, and many geologists were sent to re-examine the numerous structures that were previously known to exist in Moffat, Routt, and Rio Blanco counties, as well as search for new ones. As that part of the state is largely rough cattle country that is thinly populated, much of the territory is still government land and few ranchers have had title for more than ten to twenty-five years. The government land has been plastered with oil permits and if Uncle Sam insists on a 500-ft. well being started next year on each allotment, there will not be enough drills in the country to undertake the work. Of the numerous though usually not large structures in this area twelve are now being tested and probably they will all receive attention in the next year or two when more favorable conditions prevail. Five wells were begun on the Hamilton dome. Three wells were started in May on the adjoining Iles dome, of which the Hogan well came in a duster, from being too low down on the structure, the Dakota sand occurring at 3,366 ft. The second well, of the Midwest company, on T. 22, R. 4, S. 92, came in later at 2,636 ft. at the rate of 50 bbl. an hour. The third or Yarg well is intermediate between the Hogan and Midwest, so as to give valuable information as to the structure. The remaining wells are scattered single tests, some of which have been started so recently that they may not be completed until next spring. As the formations are mostly shales that stand up quite well and there are few water horizons, wells can be drilled in three to four months, with good luck.

Durango and Wray.—Another discovery made last spring near Durango shows that the Dakota sand is oil bearing in the southwestern part of the state, where the Leidecker well found a high-grade oil in T. 25, R. 33, S. 13 at a depth of 2,880 ft. This well is near the Hogback dome, in northwestern New Mexico, and shipments are being made to the refinery in Salt Lake City via the D. & R. G. Ry.

Near Wray, in the northeastern part of the state, close to the Kansas line, several gas wells and some oil have been found at 1,700 to 2,700 ft., which fact suggests encouraging possibilities with drilling at greater depth.

Drilling Activity.—The optimism caused by the important discoveries made within the last year has resulted in an active drilling campaign throughout the state. More than seventy wells are being drilled or have been located in twenty counties. The most active area is the Craig district, in the northwestern part of the state, where twenty-one wells are drilling or have been located in Moffat, Routt and Rio Blanco counties.

Larimer County, in the north central part of the state, which includes the Fort Collins district, has sixteen wells. The Boulder district, 30 miles northwest of Denver, ranks next in promise and activity, where two wells are drilling at the northern end of the old shallow pool on the Haystack Mountain structure that was mapped more than twenty years ago by N. M. Fenneman, of the U. S. Geological Survey. There are several other structures in this county, but only one is being tested, although there are three rigs on wild locations.

Pueblo County is quite active, with seven wells being drilled, and the Dakota sand is quite shallow in this area. Some oil and gas have been found, but thus far not in large amounts. A rig is running in the adjoining Fremont County, in which the old Florence pool is located. Five rigs are drilling in Yuma County, in the Wray gas field. There are one or more wells in Adams, Bent, El Paso, Jefferson, Kiowa, Las Animas, La Plata, Kit Carson, Prowers, and Weld counties.

As to general geology, Colorado can be roughly divided by north and south lines into three approximate equal provinces, or the plains area on the eastern side, the Rocky Mountain region in the central, and the high plateau and semi-mountainous area on the western side. The granitic Rocky Mountain province is usually abruptly dismissed by the oil men as impossible, although the large mountain parks contain extensive areas of Cretaceous and Tertiary sediments in which occur lignitic coals, and wherever there is coal, oil and gas are at least possible, if not probable (except in anthracite areas).

The eastern plains area is a more or less rolling semi-arid country that extends from the base of the Rocky Mountains to the Kansas line. Along the base of the mountains, the sedimentary measures that compose this area are sharply upturned by the action that caused the elevation of the granite masses that make up the Rocky Mountains. As the sedimentary beds outcrop against the flank of the mountains at angles of 20 to 90 deg., their thickness and character can usually be easily measured and studied. The old Florence and Boulder pools and the new Fort Collins field occur only a few miles east of these outcrops along the foothills. As the general dip of this area is to the east, but at rapidly declining rates, the general tendency is for the oil sands to increase in depth as they recede easterly from the mountains. However, it is probable that minor hidden uplifts occur in the plains area, which will materially reduce the depth of the possible oil sands.

Test Drilling Essential in Plains Region

At and near the mountains, there are usually enough outcrops to make it possible for a competent geologist to work out structures. Out on the plains, however, outcrops are scarce and satisfactory evidence is usually lacking, so test drilling—preferably with a diamond-core outfit—will probably be found necessary in most cases to insure confidence in mapping structures.

In the western province of high plateaus and local mountains, the Mesozoic sediments largely predominate, but numerous intrusives occur of old and recent age. This has resulted in the formation of many structures, and it remains to be determined by drilling as to what percentage of these are oil bearing. In this area occur the old Rangely and Debeque fields and the new Hamilton, Iles, and Leidecker pools.

In both the eastern and western provinces the oil sands are likely to range from 500 to more than 5,000 ft. deep, but commercially the eastern area has great advantages over the western, for it has no mountain

barriers to cross, with their costly freight rates and pipe-line difficulties; snow troubles are rare and it is accessible to the populous Mississippi Valley markets. The western province is not only locked within a high mountainous area, with consequent severe snow troubles, but it caters to the sparsely settled territory that has few towns and no large cities between the Rocky and Sierra Nevada Mountains.

The surface sediments of the eastern province and most of the western, when not covered by recent or residual deposits, is Tertiary or Cretaceous. The Tertiary may range from zero to 4,000 ft. and thus far no oil in commercial quantities has been found in this formation in Colorado. But it frequently covers the underlying Cretaceous to such an extent as to render the depth so great to the Dakota sands (more than 6,000 ft.) that drilling becomes prohibitory for the present. The Tertiary measures mainly consist of shales.

The Cretaceous measures may range from zero to 6,000 ft. and frequently contain coal seams in the upper portion and one or more thick sandstones. These upper sandstones are usually white to gray, and thus far have not produced oil. The middle measures are somewhat sandy and usually carry a quite persistent sandstone—the "Hygiene"—that is thought to be responsible for the oil in the Florence and Boulder pools, though shattered shales are the actual producers. Oil seeps are occasionally found in the outcrops of the Hygiene sandstone, which varies greatly in thickness, ranging from 60 to 250 ft. The upper and middle Cretaceous are mainly shales.

Detail of Geologic Occurrences

The Dakota.—The lower Cretaceous contains the rich oil-bearing horizon of the "Dakota" group of sandstones. The "Dakota" forms the first hogback as the brown, rugged sandstone that flanks the base of the Rocky Mountains for hundreds of miles and usually dips at steep angles toward the plains. The first sand of the Dakota group, known as the "Muddy," averages about 60 ft. in thickness, ranging from 10 to 120, and is the producing horizon of the Fort Collins field and the Hamilton and Iles domes in Moffat County. Under a shale interval of about 200 ft. occurs the "Lakota" sand, which is usually coarser and thicker, ranging from 40 to 200 ft., and is therefore likely to be a rich producer. As yet this second sand has not been tested in Colorado on proved structures. Sometimes an intermediate rather thin sand occurs between the "Muddy" and the "Lakota," and in the Wray district (near the Kansas line), there seem to be five or more sands in the Dakota horizon.

Below the Dakota are the Jurassic and Triassic measures, which are mainly sandstones that range from 500 to 1,500 ft. in thickness. It is possible that they may be oil bearing, but their red color is not encouraging.

Below the Triassic may occur the Pennsylvanian formation, but it is often missing and in the western area it contains thick limestones. Below the Pennsylvanian (when present) usually occur the older igneous formations, which are hopeless for oil or gas.

It will be highly interesting to the petroleum industry to watch the oil developments of Colorado to see if they will duplicate the history of California. Both were primarily mining states whose welfare depended almost exclusively on the mining industry. Modern California dates from the discovery of gold on Sutter Creek in 1849, and in the great rush to this former Mexican territory everyone either became a miner or a tradesman dependent on the business of the miners. Many years passed before the slow-growing agricultural industry was able to attain sufficient importance to compel the hydraulic mines to close down as stream polluters. Though a little oil had been produced from shallow wells drilled near the numerous seeps in California ever since 1876, it was not until 1900, when deeper drilling was initiated, that production became important. Since then it has steadily grown, as deeper pools were developed, until in 1923 it was the champion producer and from the deepest wells in the world. In the meantime the mining industry has steadily declined, until today it is only a shadow of its former great industrial importance. The oil industry today is not only vastly more important than the mining, but promises to yield far greater profits to its citizens than the rich gold mines ever did.

Improved Facilities and Market Expected by 1926

The year 1925 will no doubt record a respectable output by Colorado, but it will be at least 1926 before the tediousness of deep drilling, the shipping facilities of pipe lines, and the working conveniences of developed fields will enable Colorado to become such a large producer as to be a disturber of the oil market. By that time, if no other bonanza state makes its appearance, the steady, heavy growth in consumption will have largely emptied the present staggering load in the storage tanks, so that the flush production shall come on to a favorable market.

Today the Hamilton dome oil is selling for only $1.05 at the tanks, which in the present depressed condition of the crude oil market is not a bad price, as it costs 90c. to ship it by rail to the refinery. By 1926, this same oil, with pipe-line facilities, will probably command at least $2.50, which its intrinsic value warrants in normal times.

Safety First!

A sliding door, running between the upper and lower guide strips and the sheathing of a hoist house, fell. The upper guide loosened. The door, window, shutter, or whatever it be called in this case, was of wood, about three feet by four, and struck the hoisting engineer on the back. He fell over the steam hoist, accidently shutting off the steam. He involuntarily released the brake. The hoist had been in motion with a man on the skip, coming up. It now reversed itself, though in gear, and the surprised miner began to ride back down the shaft.

A visiting mining engineer was handling some samples, drying near the boiler, about ten feet distant. He heard no dull, sickening thud, nor any gasps, nor cries for help. For some reason he turned and saw the wooden shutter, or whatever it is, falling from the hoisting engineer's back as he sprawled over the hoist. It fell to his feet. The visitor pulled the shutter away, the hoisting engineer turned on steam, the hoist reversed, the cable flapped a mighty flap, and the man on the skip again rode up, instead of down. We will draw the asbestos curtain over what he said to the hoisting engineer.

The day before this harmless accident, two inspectors representing the insurance company that handled the compensation insurance gave this property a clean bill of health.

Progress in Hydrometallurgy of Lead-Zinc Ores

Is the Present-day Smelter Doomed? Three New Processes That Have Passed the Experimental Stage

By Arthur B. Parsons
Assistant Editor

WHEN I WAS OUT WEST last summer a very well-known and successful metallurgist told me in all seriousness that he expected to live to see the time when the smelter as it exists today will be an institution of only historic interest. And a no less competent man connected with an entirely different organization expressed his conviction that the hydrometallurgical treatment of lead ore had reached the point where it could more than compete on an economic basis with concentration and blast furnace smelting on most sulphide ores. The net recovery with mill and smelter, he points out, is only about 85 per cent; leaching with or without roasting will recover 95 per cent. The existence of the mills and smelters is a big point in their favor, but in his opinion the erection of a new lead smelter will never be justified.

The Waste of Pyrometallurgy

These are strong statements; and yet there is a plausible argument to support them. To recover a ton of lead and copper by smelting it is necessary to melt several tons of iron and silica and lime. The cost of fuel is a big factor; and the handling and rehandling of the barren material is costly. Where precious metals are present an expensive process of refining blister copper or pig lead is a necessary step in the preparing of the final products for the market. Smelters and refineries are large plants that are not only costly to run but represent huge capital investments.

Of course, hydrometallurgical processes are by no means simple affairs. It is possible to devise and to carry out in laboratory test plants, on actual ores, processes that seem practicable for dissolving all the common metals and for recovering them as separate and virtually pure precipitates. Patent offices are cluttered with thousands of schemes that are theoretically sound. But when it comes to duplicating the work in 100-ton units, difficulties arise. Delicate reactions that can be controlled to a nicety in the laboratory are not so docile in the large plant. Caustic or acid solutions, oftentimes heated, that can be handled without any thought in glass receptacles, go on a rampage when the containers are wood and iron. Some of these difficulties I shall refer to presently in describing the problems that confronted the metallurgists who developed the specific processes that will be mentioned.

On the other hand, there is reassurance in the experience of the last twenty years. Cyanidation was developed for leaching oxidized gold-bearing sand. Now, most any material containing gold and silver in sufficient quantity can be cyanided successfully. The devising and improvment of equipment for fine-grinding, classifying, pumping, agitating, thickening, and filtering pulp and for precipitating solutions was an important phase of this development, and much of this equipment, sometimes with modifications, is used in the hydrometallurgy of lead and zinc.

Although leaching of copper ore by sulphuric acid is by no means new, it has expanded greatly in recent years, and ammonia leaching of copper ore on a large scale is comparatively new. Problems arose and were overcome. Now, leaching plants are the source of a substantial proportion of the cheapest copper, and more are being erected every year. The most recent large plant is that for which ground has just been broken by the Inspiration Copper Co., in which mixed oxidized and sulphide ore will be treated.

Sulphuric-acid leaching and electrolytic deposition as a method of treating zinc concentrate has developed marvelously in a comparatively short time. The theory is simplicity itself; but the problems involved in efficient roasting, in filtration, in the purification of the electrolyte, in electrolysis, and in melting the cathode zinc —some chemical, some mechanical—have been multitudinous. Perfection is far from realization yet, but the progress made has been highly encouraging. The most recent improvement in practical application appears to be the "high acid, high-current density" process developed by U. C. Tainton, which I shall outline.

The point I am endeavoring to make is that, though the intensive development of hydrometallurgy is comparatively new, great progress has been made in devising practicable equipment and methods for conducting operations on a commercial scale. The problem of ore treatment, of course, boils down to one of dollars and cents, and if wet chemical processes are to displace the smelter in increasing degree, it will be because the manipulation is made simple and dependable and cheap enough to return a better profit. Metallurgy is the art of making money out of ore, some one has said; and the value of any metallurgical process is measured, not by the percentage recovery that it will effect, but by the money it will net from a given ore above what the best alternative process or combination of processes will net.

Hydrometallurgy at Custom Smelters

If smelting is to be displaced in large measure, it seems reasonable to predict that many hydrometallurgical plants will be large custom enterprises situated perhaps at the present smelter sites near railroad and industrial centers. Perhaps a more conservative statement of the case is to say that the smelting companies are likely to construct hydrometallurgical adjuncts to their plants, so as to combine wet and fire processes in the manner that offers greatest economy. In any event, small mines can scarcely afford either to build or to operate large reduction plants of their own, and there still will be advantages to be gained by mixing ores. The average mining company will continue to relish the opportunity to sell its ore and get the money without burdening itself with the problem of finding a market for finished metals.

Sometimes conditions may be such that the construction of a hydrometallurgical plant at an individual mine may be fully warranted. Low-grade ores that cannot be concentrated to shipping grade effectively, or ores that come from mines in isolated localities where transportation costs are high, offer possibilities in this direc-

tion. There is every indication that low-grade lead ores can be leached with the production of metal at a per pound cost no greater than the cost of lead from concentrating and smelting average galena ores.

If large custom plants are built, it will follow that concentrators at the mines will continue to be profitable, to cut down the freight bill and treatment charge. At the same time it may be that the typical lead-zinc concentrator will be a simpler plant, in that no effort will be made to separate the two metals. Silica, lime, iron, and other worthless minerals may be cut out on tables or dropped by flotation and the remaining product shipped to the treatment plant. This is based, obviously, on the assumption that hydrometallurgical methods will be so developed that a large proportion of all the metals will be recovered and that zinc penalties, and non-payment for lead in zinc or copper concentrates, or for copper in lead concentrate, will be no longer the general practice.

The "Complex Ore" Problem

There is, of course, a large element of speculation—though the idea is not so fantastic as it may seem at first thought—in what I have said. Nevertheless, in Colorado, in Utah, and in Idaho, processes that have passed the early experimental stage and for which plants are either in operation or in the course of construction point in this direction. Speaking generally, there is a definite tendency toward increased zinc content in the typical Western ore now available. It is this fact that has stimulated the development of methods for removing either zinc or lead by hydrometallurgical methods. The "complex ore" problem it is called. When an ore contains both metals in considerable proportion, and when the mixture is so intimate that reasonably fine grinding does not separate all the galena particles from the sphalerite, a complete separation cannot be made even by the most efficient methods of differential flotation. Nor has it been found practicable in commercial work to approach a complete separation even when the sulphide particles are free. If two marketable concentrates, one of lead and another of zinc, are made, a disproportionately large middling will be left. Or if only one clean concentrate is made, the other is certain to be high in metal that is not wanted.

In the Coeur d'Alene district the Bunker Hill & Sullivan company has been actively engaged for years in research looking to the development of wet metallurgical processes. Two problems were given particular attention: (a) the treatment of ores from the Star mine in which lead and zinc are intimately mixed, and which could not be exploited unless a process for recovering the zinc could be devised, and (b) the treatment of low-grade or oxidized lead-silver ores and tailing that cannot be concentrated and smelted profitably. A large plant will soon be built at Kellogg to use the "high-acid" zinc leaching (followed by high-density electrolytic deposition) according to the process successfully carried out by Mr. Tainton at Martinez, Calif. Mr. Tainton, with the assistance of W. G. Woolf, research metallurgist for the Bunker Hill company, has also developed a lead-leaching process in which electrolytic precipitation is a feature. For more than a year a 25-ton pilot plant using this method has been in operation, the feed being a rough concentrate from accumulated tailing. The original tailing averaged about 1.75 per cent lead and 0.75 oz. silver, and the concentrate 6 to 8 per cent lead and 3 to 4 oz. silver. It has been demonstrated, moreover, that excellent results can also be obtained in treating the residue from the zinc plant. The lead content of this residue varies widely, and for other reasons it is not a desirable smelter feed. Accordingly, it will be treated by the new wet process.

The treatment of a lead-zinc concentrate or a zinc-lead middling so as to recover a fair proportion of the zinc and leave a lead residue for the blast furnace is the object of the "Sulphating" process, developed by M. F. Coolbaugh, J. B. Read and O. A. Fischer and put in operation by them in a specially built plant at the Durango smelter of the American Smelting & Refining Co. The smelting company and the Metals Exploration Co. together financed the construction of the plant.

At Pioche, Nev., the Combined Metals Co., controlled by the Snyder interests, of Salt Lake, some years ago developed a large body of lead-zinc-silver ore that has thus far not been amenable to profitable treatment, on account of its so-called complexity. Edward H. Snyder has been working for several years on a metallurgical process that will make the exploitation of this ore practicable. A test plant at Florence, Colo., was operated for many months by the National Lead Co. in co-operation with Mr. Snyder and N. C. Christensen. Operation of a large plant at Bauer, near the Tooele smelter, in Utah, constructed on a similar plan, was started late in 1924, by a company financed by the National Lead Co. and managed by Mr. Snyder. Lead only will be leached for the present, but later it is planned to treat the residue for zinc by hydrometallurgical means instead of shipping it to mid-west retort smelters. A marketable zinc concentrate will be floated from the ore and zinc-lead middling will be treated by a wet chemical process.

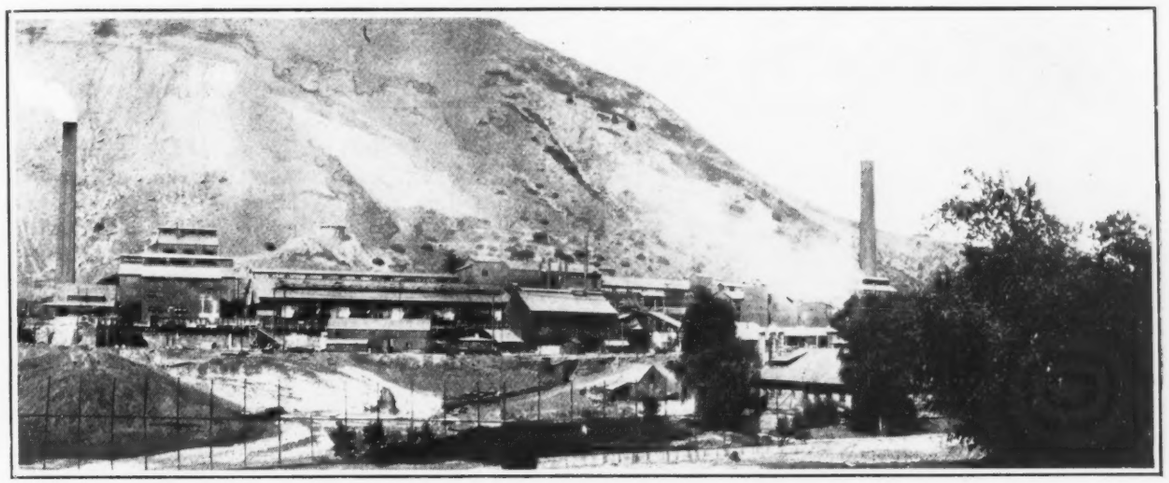
Through the courtesy of the various gentlemen named, I am able to give a general description of each of these processes. It will be observed that in each instance the process was developed to treat material that was not profitably amenable to the existing processes. But, with the application and improvement of the new processes, who can say that they will not encroach on the fields hitherto dominated by the older methods? The answer lies in the balancing of net profits from the treatment of a given ore or concentrate.

Tainton's "High-acid" Zinc Process

The treatment to be used at Kellogg on the Star zinc-lead ore by the Bunker Hill & Sullivan company combines (a) recovery of the zinc by Tainton's "high-acid" method for leaching and electrolytic precipitation, followed by (b) extraction of lead from the slime residue from the zinc plant by brine leaching and electrolytic precipitation. The zinc process was described fully by Mr. Tainton and L. T. Leyson in a paper given before the Institute at the February meeting, but I shall call attention to some of the novel features of the process and point out the advantages.

The first departure from the standard procedure is a magnetic separation of the ground calcine from the roaster. Material passing through a 30-mesh screen is separated by a simple magnetic pulley into two portions; the non-magnetic cut is largely oxide, whereas in the magnetic portion zinc ferrite predominates. Closer separation could be made with a more elaborate machine, but it is not needed.

The leaching agitators are flat-bottomed tanks fitted with mechanical stirrers instead of the Pachuca tank usually employed. Greater conservation of heat is the advantage. Calcine from the ferrite bin is first added



The A. S. & R. smelter at Durango, Colo.

The taller buildings at the left, with the near-by stack, comprise the Sulphating plant.

to a tank of hot electrolyte, about half of the quantity needed for a charge being introduced. After a half hour of agitation, the oxide bin is drawn upon for the remainder of the charge. The pulp is so thick that it is unnecessary to subject it to a special process for preliminary thickening before filtration.

The Burt pressure filter is used in preference to one of the vacuum type, because of the superior washing that it gives a cake containing much gelatinous silica. The filter drum is covered with lagging. In fact, conservation of heat at every stage is an important factor in the process of conditioning the solution for electrolysis. The reactions are stimulated by the higher temperature.

A number of improvements in the equipment used in the cell room have been made, but the important difference from the usual practice is the high-acid condition of the liquor (28 per cent H_2SO_4) and high electrical current density (100 amp. per square foot). High "hydrogen over-voltage" appears to be the essential factor in obtaining the smooth, dense, homogeneous deposit of the Tainton method, and high over-voltage accompanies high current density.

The advantages of the strong-acid procedure may be summarized as follows:

1. It permits the efficient leaching of zinc ferrite, which is the big obstacle in the obtaining of a good recovery with low-acid leaching. The method of feeding the ferrite first into the fresh solution takes full advantage of the acid strength.

2. As a consequence of (1) above, the roasters can be operated at greater capacity and with less delicate control. Moreover, the difficulty of treating low-zinc high-iron concentrates is obviated, because the formation of a considerable proportion of ferrites is not fatal to the efficiency of subsequent extraction.

3. The extraction of both zinc and copper is increased by the use of stronger solutions.

4. Virtually complete removal from the solution of arsenic and antimony is effected through the dissolving (and subsequent precipitating) of a large quantity of iron.

5. Treatment of ores high in soluble silica is made possible. In low-acid work excessive gelatinous silica would make filtration slow and costly.

6. It reduces both operating costs and capital expenditure for plant construction by reducing the quantity of pulp to be pumped, agitated, and filtered, and the volume of solution to be stored, handled, and purified. The saving is particularly large where double-leaching would be used with the low-acid method.

7. As for the electrolytic precipitation, it is expected that the cost for power will be less under high-acid conditions than with the usual procedure. A current efficiency of 90 per cent is practicable as against 75 per cent, according to Tainton and Leyson. Moreover, they declare that the electrolysis with high acid is less susceptible to costly disruptions resulting from variations in feed and incomplete conditioning. Here again, as in the leaching department, economies are effected by handling less solution for a given quantity of zinc, thereby reducing the amount of equipment required.

A marked diminution in the loss of zinc as dross in melting the cathodes has been effected by the devising of a rotary electric furnace which promises to be a success when operated on a large scale.

The following analyses show typical assays of concentrates treated at the zinc plant and the resulting lead-bearing residues from the Burt filter.

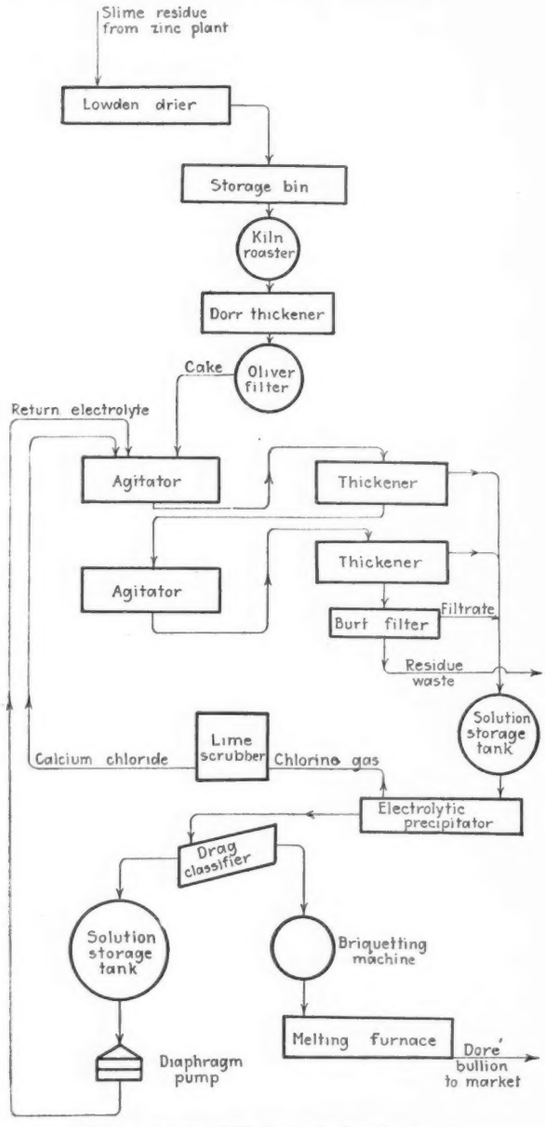
	Roasted Concentrate Feed	Residue From Zinc Treatment
Zinc, per cent	40.0	5.8
Lead, per cent	15.2	27.7
Silver, oz.	5.5	10.6
Iron, per cent	7.2	14.6
Insoluble, per cent	5.4	9.9

The lead content of the residue may vary widely from the figures given above. The subsequent treatment must be suited to a product containing any proportion of lead from 6 to 35 per cent. For this reason as well as for the fact that the residue is not a desirable smelter feed, the lead and silver are to be extracted by the lead-leaching process. The accompanying flow sheet shows the essential features of this treatment.

The leaching plant receives its feed in the form of a pulp. This is thickened, filtered, dried, and roasted. The roasting takes place in electrically heated kiln roasters. In the plant now operating at Kellogg these are revolving cylinders, supported on trunnions, tube-mill fashion, and lined with insulating brick. The inside diameter is 24 in. and the length is 12 ft. The electric resistor element, consisting of a piece of 3-in. calorized iron pipe, extends from end to end along the center of the drum.

In the material obtained from the tailing dumps, the lead is partly oxidized and partly sulphide. This sul-

phide is converted to sulphate in the roast. In the zinc-plant residues the lead is already in the form of sulphate, but it is found necessary to put it through the roasting step to obtain good extractions. Investigation has shown that at a certain critical temperature (about 350 deg. C.) the material undergoes a change



Flow sheet of Tainton's lead process

which greatly increases the possible extractions of silver, lead, and copper. It is not yet known whether this is an adsorption phenomenon connected with the dehydration of the ferric hydrate and gelatinous silica, or whether it is due to the dissociation of basic sulphates in the pulp.

No salt is at present added to the roast in the treatment of the tailing. In the treatment of zinc-plant residues the addition of a small amount of salt (about 1½ per cent) allows an increase in the silver extraction of about 8 per cent. About 98 per cent of the lead and 90 per cent of the silver are soluble without the use of salt in the roast.

If the roasting be done at too high a temperature, the lead and silver again become insoluble. It is mainly to afford very accurate temperature control that electric heating of the roasters is used. Also, the roasting cost compares favorably with that of a fuel-fired furnace, and as no combustion gases are passed through the roaster, the loss by dusting is less than 0.5 per cent.

The calcine is sluiced with water into a thickener, where various sulphates, principally that of manganese, are dissolved. The underflow of the thickener is further dewatered by an Oliver filter, a water wash displacing all but a little of the manganese-bearing solution.

The cake is then ready for leaching in return electrolyte. The agitator is a mechanical device consisting of a cross arm, revolving above the surface of the pulp, from which arms are suspended into the tank. Introduction of compressed air to effect agitation is undesirable because of the presence of free chlorine in the solution. The solution contains a mixture of sodium, calcium, and iron chlorides, with a little free chlorine and hypochlorous acid. The calcium chloride converts the lead sulphate to the chloride, which is soluble in the brine solution. The calcium sulphate precipitates in the pulp. A series treatment in a second agitator with the intermediate continuous thickening is indicated on the flow sheet. The Burt filter again is used because of the efficient displacement of solution with the use of a minimum of wash water. The vacuum filter cake with a pulp of this character is likely to crack, thereby offering channels for the passage of the wash water which prevent a good wash and a dry cake. Moreover, the Burt filter can be readily built so that no metal touches the pulp or solution. The residue is sluiced to the tailrace; the filtrate goes to the storage for pregnant solution.

The precipitating machine, a particularly ingenious device, is one of the features of the process. It has been developed by Mr. Tainton and his associates to meet the special problems that presented themselves. The cell is constructed so that the anode and cathode compartments are separated by diaphragms; the solution passes, first, through the cathode compartments, where lead, carrying silver and gold, is precipitated; and, second, through the anode compartments, where it picks up free chlorine formed by the decomposition of lead chloride. The anodes are of graphite; the cathodes are steel disks 22 in. in diameter revolving at 125 r.p.m. in the electrolyte. The lead comes down in a metallic crystalline form instead of the soft black sponge which is obtained on stationary cathodes. Every fifteen minutes the rotation of the cathodes is stopped for a few seconds. This is done by an automatic switch. During the stationary period a thin layer of spongy lead is formed and this interrupts the growth of the crystalline lead and causes it to be continually detached by the friction of the solution and carried out of the cell in the form of little granules.

The effluent solution, carrying with it the lead, flows to an Esperanza drag classifier, where the granules are removed. After washing, the precipitate is briquetted and melted to form doré bullion. It is planned later on to precipitate the copper together with the precious metals before electrolysis, thereby making a finished lead product that does not need refining either to remove impurities or to recover silver and gold.

That portion of the chlorine liberated in the anode compartments which is not absorbed by the brine is collected in a scrubbing tower charged with milk of lime. In the presence of a suitable catalyst calcium chloride is regenerated for use in the agitators. The

presence of some free chlorine in the leaching solution stimulates the dissolving of silver and makes the extraction of gold possible.

In this work the finding of suitable materials for vats, pipes, and pumps has been a major problem. Rubber, bakelite, and concrete are the only available materials that will withstand the action of the solution. For zinc-plant liquors hard lead can be used, but in the lead plant no metal of any kind comes in contact with the solution except the cathodes in the cells. An ingenious plan is the painting of wood tanks with rubber paint; but—and this is vital—the operator must "irrigate" the staves with water to keep them from shrinking and cracking the surface of the rubber coat. This is done by means of a system for circulating water in special channels at the joints. A new type of rubber diaphragm pump is one of the particularly ingenious devices that play a part in making the operations practicable. These pumps have no metal of any sort in contact with the solution and are employed for all pumping, both of solution and pulp. A large amount of work has been done in connection with various kinds of electrolytic diaphragms, anodes, and other devices.

For successful operation of a process of this kind it is essential that maintenance and attendance be reduced to a minimum. That a considerable measure of success has been attained in this direction is shown by the fact that all the operations of the plant, from the feed to the finished metal ingots, are attended to by three men and a shift boss. Moreover, the same number of men could, if the various units were larger in size, undoubtedly handle a much larger output.

A feature of the plant which is rather striking to the visitor is the absence of any trace of chlorine in the air. In most previous work of this nature chlorine leakage has been a serious obstacle to efficient work, for air containing only one part in a million of chlorine is dangerous. In the work at Kellogg, the method of cell construction and the system of chlorine absorption make it possible to maintain an atmosphere free of chlorine.

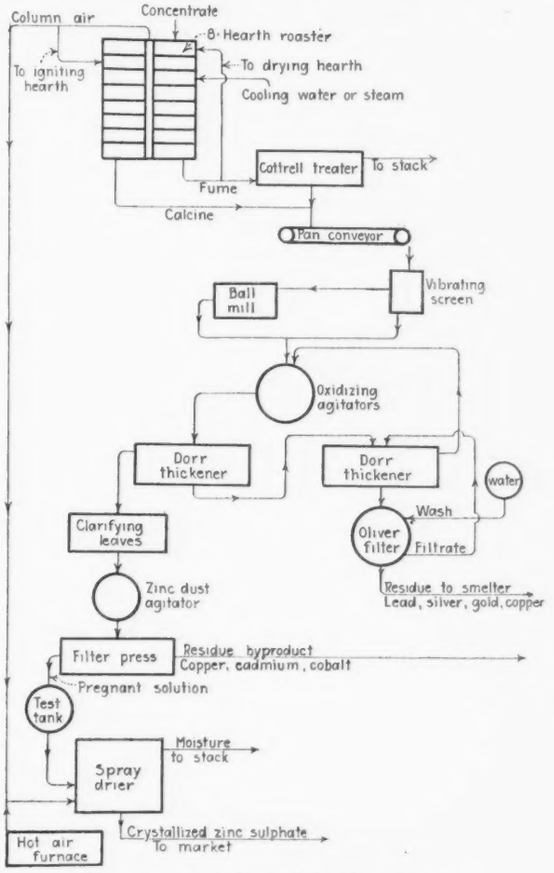
The Roast is the Feature of Sulphating Process

The significant feature of the Sulphating process, as used at Durango, is the concurrent closely controlled roast, by means of which a leachable calcine can be made even from a "dirty" concentrate. By dirty is meant a mill product that is comparatively low in zinc and high in iron; it may be either concentrate, such as is made in the treatment of Black Bear ore at Telluride, or a middling of the character produced at the Sunnyside flotation plant above Silverton. Presumably, the process will find application on ores from various districts, not only in Colorado but elsewhere. The Black Bear concentrate which was being treated at the time I visited Durango in June averaged about as follows:

Zinc, per cent	28	Insoluble, per cent	12
Lead, per cent	10	Sulphur, per cent	29
Copper, per cent	5	Silver, oz	12
Iron, per cent	18	Gold, oz	0.5

The accompanying flow sheet shows the procedure of treatment. It is by no means complicated. Nevertheless, Messrs. Read, Coolbaugh, and Fischer, who developed the process through laboratory and pilot-plant stages, met many obstacles in putting the large plant into operation. The usual troubles that are expected in starting the new plant were complicated by mechanical and manipulative problems that could not be entirely foreseen.

The roaster is an eight-hearth Skinner revolving-rabble furnace, of 20-ft. internal diameter. The draft is downward, concurrent with the concentrate, which passes a 60-mesh screen and is fed in damp condition. The drying or top hearth of the furnace is inclosed, and arrangement is made so that a portion of the effluent gases are bypassed from the flues and used for drying the feed. Ignition takes place on the first roasting hearth, where the hot air from the rabble arms is introduced to promote combustion. On the next hearth provision is made for the introduction of steam or water sprays to retard the reaction and prevent excessive temperatures in the early stages of the roast. The array of large asbestos-covered ducts surrounding the upper part of the furnace is rather unusual, but it is amply justified in affording close regulation of the temperatures on the various hearths, and conservation of heat. In this particular, the roaster is entirely self-sustaining at a capacity as low as 30 tons per day and with a feed containing as low as 20 per cent total sulphur. The normal capacity is 40 tons, and it is expected that this will be increased materially. Direct roasting costs have been about $1.35 per ton, but these obviously can be reduced by the installation of additional units.



Flow sheet of the Sulphating process

In the initial stages of the roast, a part of the sulphide minerals, particularly those of iron, lead, and copper, are converted to oxides and sulphates. The temperature should not exceed 550 deg. C. at this point, and it is for this reason that provision is made for cooling the third, or the second roasting, hearth. As the oxidized products are rabbled into the bed they react with the remaining sulphides to desulphidize the entire mass. In the meantime, in the presence of ferric

oxide, as a catalyzer, sulphur dioxide has been converted to sulphur trioxide, which reacts with zinc oxide to form zinc sulphate, as the charge continues to pass over the lower hearths of the furnace along with the gases from above. The highest temperature should be about 700 deg. C. and is usually reached on the fourth hearth. The temperature of the effluent gas is about 315 deg. C. In the presence of so much iron some zinc ferrite will be formed. If this is formed under proper conditions, however, most of it can be sulphated with sulphur trioxide. This feature of the roast is to be discussed by Mr. Read in a paper which is in the course of preparation. Black Bear concentrates have been roasted to the point where 85 per cent of the zinc is water soluble and only 0.5 of the sulphur in the calcine is in sulphide form.

The original Cottrell treater was of the wire type, but did not effect a satisfactory clearance. A treater of the plate type has been installed to supplement the other and provide for additional roasters.

A Traylor vibrating screen, equipped with 10-mesh wire cloth, cuts out the oversize for grinding before the calcine is ready for leaching. The leaching agitators, or "spumers," are designed on the principle of the Ruth flotation machine, atmospheric air being sucked in through the hollow vertical impeller shaft. The agitators serve a threefold purpose: they pulp the calcine, dissolve the zinc sulphate, and oxidize and precipitate the iron and most of the copper. The pulp from the agitators has a temperature of about 70 deg. C.; the liquor itself has a specific gravity of about 1.5, and is corrosive to copper, brass, or iron. As a consequence, the thickeners, pumps, and other equipment in the leaching department operate under unusual conditions, and considerable difficulty was experienced at the start. Much of the trouble has been overcome, however. The Oliver filter works well, as there is little colloidal matter, no gelatinous silica, and little ferric hydrate to cause trouble.

Spray Drier Is a Feature

The spray drier, made by W. L. Fleisher & Co., is essentially a rectangular chamber, the size of a small room, with a floor consisting of hoppers. Along one side of the room near the bottom a large stream of low-pressure hot air is introduced. Halfway up the same side, atomizers, in a horizontal row, spray the zinc sulphate solution into the stream of hot air. The mixture swirls around in the chamber, the crystallized sulphate dropping into the hoppers and the water-laden air being withdrawn through an orifice across the top of the side on which the air and solution are introduced. The drier has operated successfully in a number of other industries, but under the new conditions imposed in this installation the capacity has not yet been brought up to the guarantee, in spite of numerous changes. Further alterations are expected to produce satisfactory results. The standard is to dry to two molecules of crystallization.

What is to be done with the zinc sulphate? Three avenues are open for the disposal of this product:

1. The marketing of the zinc sulphate as such, which is the present procedure. There is a limited market in the manufacture of lithopone, but it cannot be depended upon to absorb any great production.

2. A lead-free zinc oxide, for which there is a wide market, can be made by roasting the sulphate with coal at low temperatures and then purifying the crude zinc oxide thus produced in a reverberatory furnace or on Wetherell grates.

3. The production of electrolytic zinc from the zinc sulphate solutions. If this avenue is employed, a considerable amount of sulphuric acid, in excess of that needed in the process, will result. The sulphuric acid will be an asset in some localities but will be worthless in others. In that event, the acid will be depleted of zinc, so far as practicable, and then returned as the cooling agent to the upper hearths of the roaster. The latter procedure involves the elimination of the sulphur through the stack, and an increased amount of water-soluble zinc. The installation of an electrolytic plant in a locality where the sulphating process is adopted would of course depend upon the assurance of a source of low-priced power and an adequate supply of suitable ore.

The Snyder-Christensen Process

The process to be carried out at Bauer by the Combined Metals Reduction Co. is based on various patents of N. C. Christensen. An auxiliary to the main plant is one for the manufacture of hydrochloric acid according to standard practice. Crude salt is obtained from producers on the shore of Great Salt Lake and sulphuric acid from the Garfield smelter. The proximity of sources of these necessary reagents and the consequently low freight rates was one of the reasons for erecting the plant at Bauer. Another reason was the probability of treating custom ores from mines tributary to the Salt Lake district. The low freight rates on ores to the International, A. S. & R., and United States smelters apply to shipments to Bauer. From a technical standpoint the process can extract lead from almost any mineral product containing the metal; its practical application is confined to materials that for any reason cannot be treated advantageously by concentration and smelting alone.

The features of the treatment are the leaching by agitation of unroasted ore in a hot brine solution containing a small quantity of hydrochloric acid; filtration and washing with hot weak solution and water; precipitation of the silver by means of lead in some form; precipitation of the lead by cooling the pregnant solution; and reduction of the lead by melting with a mixture of lime and coal dust. The solutions are circulated through "spray heaters" for re-use. The lead precipitation is based on the simple fact that a hot liquor at 90 deg. C. will hold 8 to 10 per cent lead, whereas when cooled to 30 deg. C. only 1 per cent will remain in solution. The most important difference between this process and that used by the Tintic Standard Mining Co. at Harold, Utah, is that a chloridizing roast is eliminated. When ground very fine, galena will dissolve in a hot, saturated, and acidulated brine. The precipitation is likewise different, as in the Tintic Standard plant detinned iron scrap is used as a precipitant.

Special Equipment Required

As with most of these processes, the design of special equipment for conducting the reactions is an important feature. The "cooler" or precipitator and the "heaters" for the leaching solutions are the result of a long period of experiment and test operating in which various acid-resisting materials and numerous mechanisms were tried. In essential phases of construction the coolers and heaters are alike. In operation they differ in that hot air from a firebox at the effluent end is drawn

Plant of the Combined Metals Reduction Co. at Bauer, Utah

On the right, the old Honorine mill, which has been remodeled; on the left, the new plant as it appeared last summer.

through the heater by means of an exhaust fan in the flue; whereas, cool air from the outside atmosphere, drawn in the same way, is the cooling medium in the precipitator.

Novel but Efficient Precipitation

The precipitator was developed first, the plan being later adapted to heating the solution. The cooling chamber is a horizontal flue-like passage 60 ft. long, 7 ft. wide, and 7 ft. high. This chamber is made of concrete painted inside with several coats of tar and finally lined with acid-resisting brick. At intervals of 8 ft. along the bottom are brick baffles 3 ft. high; alternate baffles adjoin one wall and approach within about 8 in. of the other, thereby guiding the flow of solution in a meandering course. They serve to increase the distance that the liquor must travel, about fifteen minutes being the period of treatment. In each of the compartments formed by the baffles are two heavy cast pulleys on horizontal shafts, the bearings of which are outside the chamber. They are 20 in. in diameter and 6 ft. long, set so that the faces dip slightly into the solution. When these pulleys are revolved at 700 r.p.m., sprays of liquor are thrown into the upper part of the chamber, thus exposing large areas to the cooling action of the air. This has proved to be the most efficient cooling method yet tried. The crystallized lead chloride is finely divided and is carried out by the solution. It settles in a thickening or collecting tank. The sludge is fluxed in a wet condition with lime and coal dust and reduced to bullion in a reverberatory furnace.

The spray heaters are similar in construction but somewhat longer, so that the loss by evaporation may not be excessive. At the start the fresh concentrate is emulsified with a small quantity of cool weak solution before the heated solution is added. This effects a thorough wetting and mixing with the minimum loss of heat. The heated solution is added to the pulp in a supply tank which feeds the four extracting agitators. These operate continuously, fresh strong acid being added as required to give the strength needed for the maximum extraction.

The agitator is specially designed. It consists of an inclosed chamber 6 ft. square and 10 ft. long, fitted with a horizontal shaft on which are mounted eight paddle arms. The paddles and the "box" itself are both made of cypress protected with asphaltum paint. The pulp level is well below the center line of the chamber. The dilution of the pulp is about 2½ parts of solution to 1 part of concentrate. The upper part serves as a splashing box and tends to conserve the heat. Hydrogen sulphide gas is generated with the decomposition of the lead sulphide, and is allowed to escape through the top.

The Sweetland filter is lined with copper-silicon alloy which has proved amply resistant to the comparatively weak acid solutions that are used in the process. The filtered sludge contains the zinc and some lead, but on a product containing 18 per cent lead and 5 per cent zinc the zinc residue can be reduced to 0.5 per cent lead consistently.

The precipitation of silver from the filtrate is one of the phases of the problem that is not definitely settled, farther than that lead will no doubt be the precipitating agent. Granules or sheets or some other form may be chosen ultimately. Some modification of the zinc box for treating cyanide solutions of gold and silver may prove to be the most suitable equipment.

An interesting point is the use of the slag from the reverberatory furnace as a source of new brine, the calcium chloride being an effective substitute for the sodium chloride. Provision is made also for the use of the hydrogen sulphide gas from the agitator to provide calcium hydrosulphide [$Ca(SH)_2$] with which to clean the circulating brine if it becomes fouled with zinc.

The ore from the Combined Metals mine is low in lime and assays about as follows: Silver, 8 oz.; lead, 8 per cent; zinc, 18 per cent; silica, 26 per cent; iron, 14 per cent.

The plan is to float a high-grade zinc concentrate from this ore, leaving a product containing about 18 per cent lead and 5 per cent zinc for treatment in the lead-leaching plant. Until this department is working smoothly the zinc-bearing residue from the Sweetland filters will be shipped to zinc-smelting plants, but later it is planned to install a plant for the chemical recovery of the zinc.

The Gordon Process

A process on which considerable experimental work has been done in Colorado is the so-called Gordon "gas-house-liquor" process. It deserves mention, perhaps, because it seems theoretically sound, and because its sponsors consider it most suitable for treating typical zinc-iron-lead middlings. They should be low in iron to minimize the formation of insoluble ferrites, and low in lead. Briefly the process consists of roasting; leaching zinc and copper with an impure ammoniacal menstruum; precipitation of copper with zinc, and of zinc as a carbonate in standard ammonia stills; and calcination of the carbonate to impure zinc oxide. The feature of the process is the use of byproduct gas-house liquor as a cheap source of ammonia.

Discussion

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

Water Connections for Rock Drills

THE EDITOR:

Sir—In the article "Care and Use of Rock Drills" in your issue of Nov. 1 is the following suggestion:

"Rubbers especially made for the water spuds are available, and, if slightly too long, they will close the holes in the brass screen when the water connection nut is tightened. If this occurs, remove the rubber and cut off an eighth or a sixteenth of an inch and replace it."

The authors might have added that if too much was cut off the rubber it would cause the water connection to leak, and it would also leak as soon as the rubber had worn a little or lost its elasticity.

The style of water connection in question is that shown in Fig. 1. It depends for its tightness on the elastic deformation of the rubber. The rubber must be squeezed down, and the hole must be partly closed, as there is no other place for the displaced material. If the hole is not closed enough, the connection will leak, and if it is closed too much the water will be shut off.

As there is only a small area on the end of the rubber to withstand wear, and as the friction is high, wear is rather rapid, and the rubbers must be frequently replaced. The two parts which form the space for the rubber must be accurately machined and the rubber itself should be made to exact dimensions.

Fig. 2 illustrates another type of water connection on

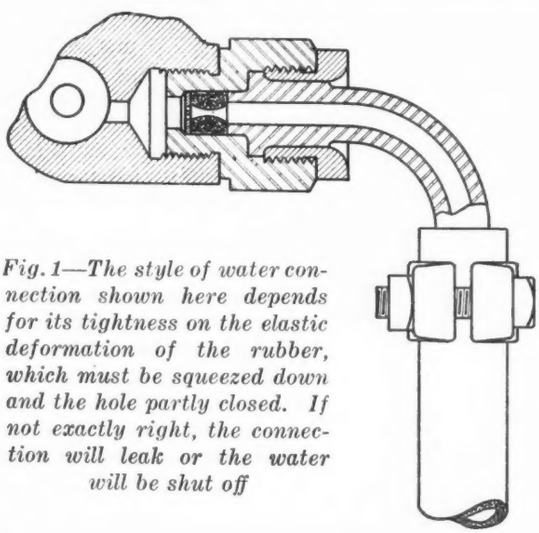


Fig. 1—The style of water connection shown here depends for its tightness on the elastic deformation of the rubber, which must be squeezed down and the hole partly closed. If not exactly right, the connection will leak or the water will be shut off

a different principle. In this case the packing is a leather washer, held tight by water pressure. The washer is cut flat and is forced into a saucer shape in assembling. The friction of the wet leather washer is **low, so that wear is small and the life is long.**

The accuracy of the parts is not so essential as in

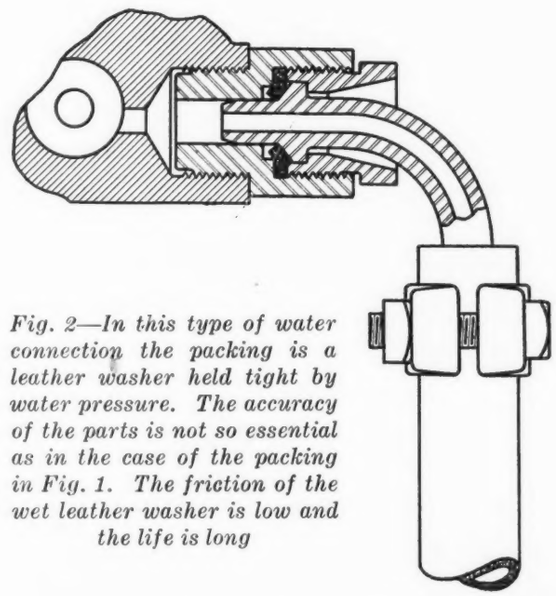


Fig. 2—In this type of water connection the packing is a leather washer held tight by water pressure. The accuracy of the parts is not so essential as in the case of the packing in Fig. 1. The friction of the wet leather washer is low and the life is long

the case of the packing in Fig. 1. The packings can be made locally. This leather-packed water connection was introduced on rock drills in Canada about four years ago and has found general favor among miners. It is now the standard water connection for all drills sold by Canadian Ingersoll-Rand Co., Ltd.

Sherbrooke, Quebec. H. V. HAIGHT.

Colorado's Ore Testing Laboratory

THE EDITOR:

Sir—Referring to your editorial of Nov. 29, regarding the Colorado ore-testing laboratory, I wish to give my viewpoint. In the first place I wish to state that I own my own ore-testing plant. I can do everything in my own plant that can be done at Golden, but on a much smaller scale. In the second place, I wish to stress the fact that this letter is simply an expression of my own ideas. I am writing this in an isolated spot in the mountains. I have never discussed the problem of the testing plant with Dr. Alderson or with anyone connected with the School of Mines. Certain facts, however, are obvious, and these facts I wish to present herewith.

I wish to register my hearty approval of the Editor's remarks about the government keeping out of private business. That happens to be a little pet hobby of my own. In this particular instance, however, "it is a condition that confronts us and not a theory."

The Golden testing plant was built. It was equipped with expensive machinery. A very large percentage of the cost was met by private gifts. My personal impression is that practically all of the machinery was donated by various machinery firms. I am perfectly willing to concede that it is an open question whether or not

the money invested in the plant could not have been better spent in some other way, but that question is a thing of the past. The plant is built and spendidly equipped, and the mining men and mining machinery firms that gave so liberally toward its construction do not like to see it stand idle.

The original idea was to let the students and professors use the plant to educate the students with practical operating experience. I think I may state without fear of successful contradiction that it is utterly impracticable to turn over a lot of intricate machinery to students and college professors and at the same time expect it to be kept in working order. I have never used the Golden plant, but I came near doing it at one time. I had a carload of ore to crush, sample, and reduce. This lot was too big for my plant at that time. Doctor Alderson very kindly offered me the use of the Golden plant. It was vacation time and the plant was idle. I carefully looked over the plant and concluded that I could install a 5x3 ft. ball mill in my own plant for less money than it would take to repair the Golden plant and put it in condition for work. So I installed my own ball mill and did the job at home.

I would not mention this incident if it was not typical, not only of this testing plant but of every college-owned plant in the West. Some schools have had better luck than others, but I think all of them have learned that undergraduates are likely to destroy fine machinery. If a corps of practical mill men is retained to keep a plant in good condition, the students do not get practical experience. If the plant is turned over to the students they ruin it. So for several years the Golden plant was not as active as the donors had a right to expect it to be. The school has now repaired the plant and started it up for the benefit of the mining industry at large rather than for the schoolboys alone. I think the plan is entitled to a fair trial and am perfectly sure it is going to get one.

As the owner and operator of a rival testing plant I welcome any move which will rejuvenate mining.

With nearly all items of mining and milling costs higher than they used to be, there are two ways to make mining pay; namely, to find higher grade mineral or get more out of the ore at hand. Golden has already been helpful in the latter cause, and from my limited point of view I see no reason why the good work should not continue. GEORGE J. BANCROFT.

Denver, Colo.

A Curious Occurrence of Platinum

THE EDITOR:

Sir—Through my association with the Idaho Bureau of Mines and Geology I had occasion recently to examine some black sand for possible platinum group metal. The sample in question was sent in by the Superior Dredging Co., operating at Bridgeport, Ore. It was obtained from the clean-up of the table riffles. One-half of the sample, when assayed according to U. S. Bureau of Mines methods, showed platinum, iridium, and a trace of ruthenium. Osmium was suspected but not verified. The other half of the sample when concentrated in a horn spoon and examined under the binocular microscope showed grains of platinum-iridium, tin-white in color, with basal cleavage, which had a hardness of approximately 7. One or two grains resembling osmiridium were also observed. In addition to these characteristic grains a number of small ring-like objects were present in the sample. These rings, nine of which are shown in the accompanying photomicrograph, resemble segments of spirals rather than true circles. The photomicrograph shows a magnification of some 15 diameters. None of these rings were closed and the two ends were turned slightly away from the plane of the ring itself. The metal is circular in cross-section, and the suggestion is that of pieces of very small springs. The actual diameter of the rings is approximately 0.5 mm. The metal composing them is insoluble in hot aqua regia. Some circular rods of smaller cross-section than the rings, and differing from them by showing a bright blue iridescence, were also found. One of these can be faintly seen in the photomicrograph below and to the right of the six-sided grain, at the bottom of the upper right-hand quadrant.

The origin of these rings and rods is mystifying. Some of them were sent, mounted on a slide, to C. W.

Photomicrograph of grains of platinum-iridium, together with rings. Magnified 15 diameters

Davis, platinum specialist of the U. S. Bureau of Mines Rare and Precious Metals Station, at Reno, Nev. Mr. Davis was unable to determine the manner of their occurrence. They were next sent to Dr. James Lewis Howe, of the Department of Chemistry at Washington and Lee University, Lexington, Va., author of an exhaustive bibliography of metals of the platinum group. Dr. Howe was inclined to regard their occurrence as artificial. His opinion was, however, not a positive conclusion, but rather a negative deduction based upon the fact that he could not explain their natural origin.

The question is, are the rings natural or artificial? The thought that someone may be able to explain this unusual occurrence invites discussion. That they are artificial and were placed there by man seems hardly reasonable. The operation from which they are derived is well financed and in substantial hands. The prime object is of course the production of placer gold, and platinum production is an incidental and practically negligible side issue. Furthermore, the sample con-

tains considerable platinum-iridium in grains of typical normal occurrence and of natural origin, and the presence of the platinum-iridium (?) rings and rods would change this analysis only slightly. These facts seem to dispose of the possibility that the rings were added to the sample with the purpose of salting it. On the other hand, it seems equally difficult to explain the natural occurrence of rings and rods of a metal insoluble in hot aqua regia. Possibly some reader of *Mining Journal-Press* may be able to contribute some information on this problem.

Moscow, Idaho. ERNEST W. ELLIS,
Assistant Metallurgist, Idaho Bureau of Mines and Geology.

The Case for the Ten-day Miner

THE EDITOR:

Sir—Speaking of ten-day miners—after mining about thirty years I find myself slipping into the same class. I will unravel a few of the causes for these changes as I see them.

To make myself plain, I will show some of the variations between the mine boss and miner. At present we have the gasoline hammer for drilling hard rock; also the compressed air, steam, and boring machines. In some isolated places we find the man-muscled single- and double-hand mining hammer. Before these modern machines came on the market some miners would drill holes about three inches in diameter, fill the holes with slacked lime, and drive in a wooden stopper, leaving a small vent hole to allow a certain amount of water to soak in. This process causes the rock to crack. Others would heat the rock they desired to move, with wood fires, and later throw cold water on, causing it to contract and break. During all these changes in mining methods there have been many ways of handling mine labor. I have crosscut the formation from the Mexican line to Alaska, and labored in many holes and mines. The boss code seems to be "get along with me, or drag your time." Every sane miner knows the boss can settle any fair discussion or argument, with "time book." This is one reason that one hundred and fifty strange miners may be found on a monthly payroll, where the mine has a working force of, say, sixty miners.

Most miners will sell a full shift of eight hours' labor if treated halfway decent. They realize that an honest company has to dig the ready cash from old Mother Earth, to meet the payroll expenses, and the pay rock has to be kept moving toward the mill or smelter. All miners appreciate real sunshine, and a rest away from the deep, wet, and gassy mines, when they have a bankroll saved up, and they light out for the cities, and have what they call a "good time." There the miner knows he is safe from heavy caving ground, and there is no danger from a quick fuse causing an explosion before he can make a get-away to a safe place.

I remember working in a mine where we had to ride up and down on a sinking bucket. That shaft put me in mind of a hardware store. There were enough nails projecting from the timbers to build a small bungalow in California. The pump man would leave all his tools scattered around on the wall timbers. Any tool might drop accidentally down the shaft, and you could look to St. Peter for your next pay check. I took soundings from the miners about the nature of the boss. I intended to call his attention to the condition of the shaft, but I was told he carried his time book in his hip pocket, and I refrained. I worked ten shifts, and quit.

You will find that these ten-day shifts will sharpen your knowledge of mining. You will come in contact with the very latest fashions and styles invented to move hard rock, and in time you will acquire a hankering to keep moving, unless you find a boss that knows his business from A to Z, and lets the fact be known by his actions—meeting you halfway, and keeping in tune with his mine labor.

I am trying, friend, to make my ideas clear as I have seen them. A miner's liver turns over when he observes the underground workings of some mines. He knows that the boss would make a better hand in a slaughter house, by the way he has butchered up a good mine. Speaking of getting in tune—try swinging a fourteen-pound sledge hammer for a blacksmith on a heavy weld. You will find him keeping in tune with you, by striking the anvil every other blow with his striking hammer. If he should refuse to perform as I have stated, his helper will blow up, and quit. A good blacksmith will not work on a cracked anvil. He wants one with a clear tone.

Here is where I will state a fact about a mine that was cracked, or out of tune. I rustled a mine in Arizona in 1920, called the "Colorado." At present it is owned by a Mexican. This old silver mine had an incline shaft, about 950 ft. deep. I found about a dozen Mexican miners and a couple of Americans on the job. This mine looked a little queer to me, and I decided to make a trip down to the bottom of the shaft. The miners were taking out a small high-grade streak, and packing the ore out on their backs. Considerable stoping had been done at several places, along the sides of the shaft, about 60 ft. in width. There was not enough timber or wood in this mine to build a fire to cook your coffee on. Coming up the shaft, about every hundred feet, I noticed a stone image. The miners called him "Jerusalem Slim." On each side of Slim was a burning candle. After making some inquiry into this new style of mining, the Mexicans explained that a Sky Pilot had put the "hokey-pokey" on the candles. This was supposed to be a sure cure for holding up heavy caving ground. If you doubt this information, friend, put up the price of an affidavit, and I will send you a sworn statement by mail.

Well, Editor, I sometimes believe the old human mine boss is gone—the one who would stop and borrow a pipeful of your tobacco when he was making his rounds, and pass a few remarks about the work, inquiring about the condition of the ground, timbers, tools, and other details, and, when you figured your road stake would drive your tunnel or shaft another 50 ft., you would notify the boss, and tell him to grab another man to take your place, and when you were about ready to pack up and leave, the boss would say, "Old-timer, you had better take along a few pounds of powder, some caps and fuse. This mine is about worked out, and we will need another one pretty soon. I hope you strike it rich this trip, and will be able to make a trip to the big city, and shake hands with the Goddess of Liberty, and don't forget, old-timer, if ye don't make 'er pay this time, your job is always open."

I believe that the mining industry is all out of tune at present. E. B. FOSTER.

Kingman, Ariz.

News of the Week

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Summary

IT IS REPORTED from Chile that the Braden Copper Co. has increased its current rate of output to 15,500,000 lb. per month. Still higher production is anticipated later in the year.

After being drifted on for 300 ft. the new oreshoot in the Star mine at Burke, Idaho, is 20 ft. wide and contains 12 per cent combined zinc and lead.

Gold production in South Africa for 1924 was the largest in history, totaling about 10,300,000 oz.

Production of lead and zinc in British Columbia increased largely during 1924, according to the Minister of Mines.

No immediate increase in production is expected from the Michigan copper mines, which produced 10,800,000 lb. in December. Shortage of labor is a factor in the situation.

La Corona Mining & Milling Co. has started its newly erected concentrator at the properties it is developing in Nayarit, Mexico.

The Calumet & Arizona Mining Co. has opened 15 ft. or 14 per cent copper ore in its Junction mine at Bisbee, Ariz.

A production of $2,450,000 worth of bullion in 1924 marked by far the best year for the Tonopah Extension Mining Co. in Nevada.

British Columbian Metal Output Gains 25.3 per Cent

Lead and Zinc Responsible for Increase Copper Production Up but Value Down

The official estimate of the value of the metal production of British Columbia for the year 1924, issued by the Minister of Mines, places it at $32,310,600, an increase of $6,543,538, or 25.3 per cent, as compared with that of the previous year. The most encouraging and interesting feature of the figures for 1924 is the growth of lead and zinc production. The province is given credit for 131,881,000 lb. of lead, which is 35,217,848 lb. better than the 1923 record, or a monetary increase, estimated, of $4,294,630. Zinc production totaled 64,500,000 lb. in 1924, which is 6,156,438 lb. more than the output for 1923, and an improvement of $765,247 of value. The details of production and value follow:

There were advances also in respect of gold, both placer and lode, and silver; but copper, although greater in volume than in 1923, shows a decline in point of value. The details follow:

	1923 Quantity	1923 Value
Gold (placer)	20,320 oz.	$420,000
Gold (lode)	179,245 oz.	3,704,994
Silver	6,032,986 oz.	3,718,129
Copper	57,720,290 lb.	8,323,266
	1924 Quantity	**1924** Value
Gold (placer)	20,500 oz.	$425,000
Gold (lode)	220,000 oz.	4,540,000
Silver	6,693,000 oz.	4,471,000
Copper	63,185,000 lb.	8,214,050

Braden Copper Co. Producing 15,500,000 Lb. Per Month

COPPER production by the Braden Copper Co. at Seweli, Chile, has reached the rate of 15,500,000 lb. per month and still higher production is expected during 1925.

The cost of producing copper in 1923, including taxes, marketing and plant depreciation, was 8.902c., when production was at the rate of 11,600,000 per month. Positive and probable ore reserves as of Dec. 31, 1923, amounted to 258,940,000 tons of 2.24 per cent ore.

The company has its own concentrator, smelter, power plants, and railroad. The Kennecott Copper Corporation controls Braden through ownership of nearly all the stock.

Will Develop Burns Lake Claims

The British Columbia Mining & Development Co. has been organized by English capitalists to take over and develop the Harriett group, north of Burns Lake, on the Grand Trunk Pacific Railway. On the Taltapin group, which adjoins the Harriett, nine lodes, ranging from 35 to 55 ft. in thickness and assaying up to $65 per ton in gold, silver and lead, have been uncovered. Arthur Wood is the managing director of the new company.

Tonopah Extension Earned $800,000 Net During 1924

Gross Production $2,450,000 — West End, Tonopah Mining, and Tonopah Belmont Also Active

The Tonopah Extension shipped bullion valued at $189,156, from Tonopah, Nev., during the month of November last. Operating costs were higher and grade of ore and profits lower. Production for 1924 will be by far the largest in the history of the company and will approximate $2,450,000 gross, with a net profit of around $800,000.

The Cash Boy shaft is practically completed to the 2,375 level, and it will soon be possible to accomplish more development below the 2,125 level, the lowest on which extensive stoping is now being carried on. It is reported that as soon as the Cash Boy sinking is completed work will be started on the new shaft, to be situated a half mile west of the Victor shaft, the newest opening in active operation.

The West End is producing 125 tons of ore per day from various sections of the mine. Active development work is being carried on in the vein under dispute with the Tonopah Extension company, and it is likely that the trial of the case will come up within the next few months.

The Tonopah Mining Co. is producing 75 tons of ore per day, and the Tonopah Belmont 100 tons. The Belmont is doing extensive development on the 1,500 level. Prospecting continues in the western portion of the district by various smaller interests.

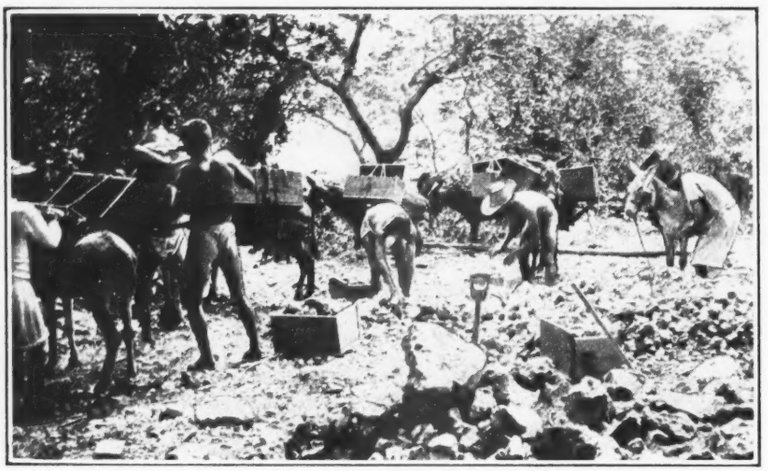
La Corona Company Starts New Mill in Nayarit, Mexico

Old Properties Reopened—Gold and Silver Recovered by Flotation—Large Area Controlled

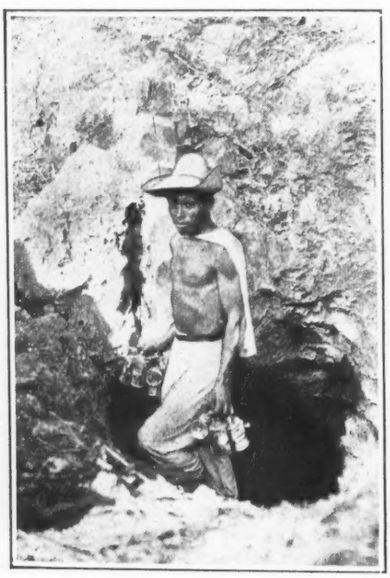
By Albert E. Maas
Special Correspondent, Mazatlan, Sinaloa

A NEW fifty-ton flotation plant built by the La Corona Mining & Milling Co. was recently started on silver-gold ore from La Magnolia and El Tejon mines near Yago, Nayarit, Mexico. The company controls a number of other properties which it plans to explore. It is an American corporation, with offices in Los Angeles and San Francisco. Field management is in charge of Frank E. Davis, an American mining engineer of many years' experience on the West Coast of Mexico. He is also the president of the local company, which is a Mexican subsidiary.

The mines are situated about two miles east of Yago in a series of high hills. Yago is a shipping point on the Southern Pacific of Mexico railroad and is at the juncture of the above-named lines and the Santiago River. Transportation is thus available either over the railroad or via the river, which touches tidewater at San Blas, Nayarit.



Loading ore on burros, at the old La Cucaracha mine, for transporting to the mill



Typical Mexican miner
Carbide lamps have replaced candles even here

Operations of the company were begun last February, and in spite of the De la Huerta revolt and numerous other difficulties incidental to obtaining prompt shipment of mining machinery and supplies, substantial progress has been made. La Magnolia, which is a noted old Spanish mine, formerly known as the La Cucaracha (The Cockroach), has a history dating back to the time of Cortez, and according to legend was concealed and abandoned by the Spanish padre miners when forced to flee Mexico in 1812, the year Mexico declared and won her independence from Spain.

This ancient mine was recently "rediscovered" by Davis. Davis had searched for this property, when opportunity presented, over a period of ten years without success. But it was only by chance and during the course of operations at the El Tejon mine that its near-by presence was disclosed.

The La Cucaracha proved to be on a vein running nearly parallel to that of the El Tejon and about four hundred yards north. The property was cleaned out by Davis, and this necessitated exceptionally heavy timbering in shaft and open stopes. At about 120 ft. depth the vein was found in place and measured about 17 ft. in width, all of milling ore.

Leading values are gold and silver, about equally divided. The development work now being carried out in new ground will serve to better determine the richness of the high-grade ore, as the ancient workers removed the richer portions of the vein. On the foot-wall side occurs a streak carrying silver, copper and antimony, running to above $400 per ton. In a drift being run on the 100 level along the center of the vein, bonanza ore of gold and silver is being opened.

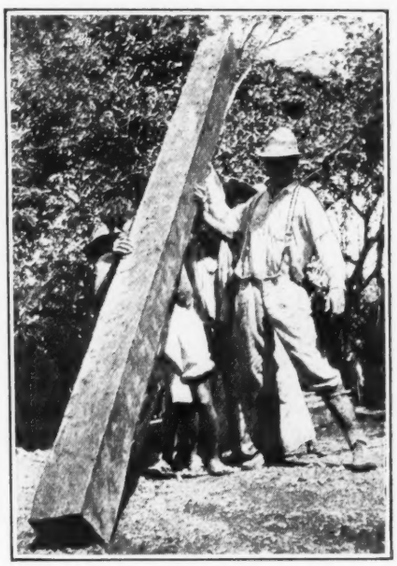
La Magnolia lies on top of a high hill, and present workings are clearly visible from the railroad. The vein occurs on a contact of porphyry and diorite. Mining conditions are favorable, there being easy transportation and an abundance of timber, fuel, and water.

The El Tejon mine, a virgin property, was discovered by Mr. Davis several years ago. A tunnel 600 ft. in length along the course of the vein has attained a depth in ore of 210 ft. The surface width of the El Tejon vein averages 5 ft., with values in gold and silver of about $40 per ton. But in the same oreshoot at the tunnel level the vein has widened to more than 30 ft., with values disseminated throughout the entire vein. As yet no high-grade ores have been encountered.

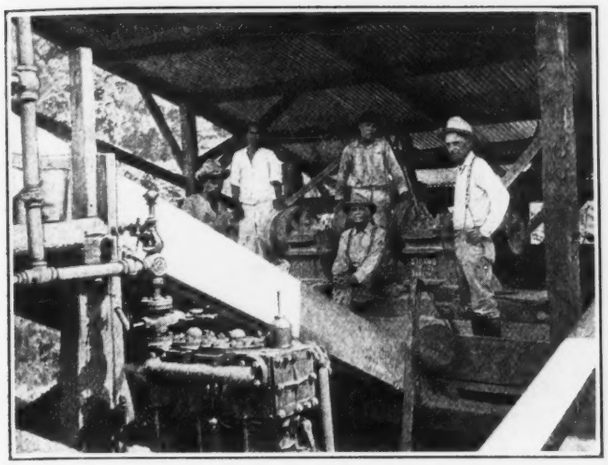
Ore from the El Tejon is hoisted to the mill from the tunnel level by means of a short incline railway and steam hoist. From the La Magnolia it is packed on burro trains, but a graded road is now under construction and Davis plans the utilization of motor trucks.

The mill, recently completed, has a daily capacity of forty to sixty tons, according to the particular ore being milled, that of the La Magnolia being very hard. Power is furnished by two 50-hp. steam boilers which operate a steam engine for the mill. Two smaller engines operate the air compressors, as all mining is done by air, and these have a combined capacity of 400 cu.ft. per minute. A Fairbanks Morse gas engine and generator furnish electricity for lighting the mill and camp and all underground workings.

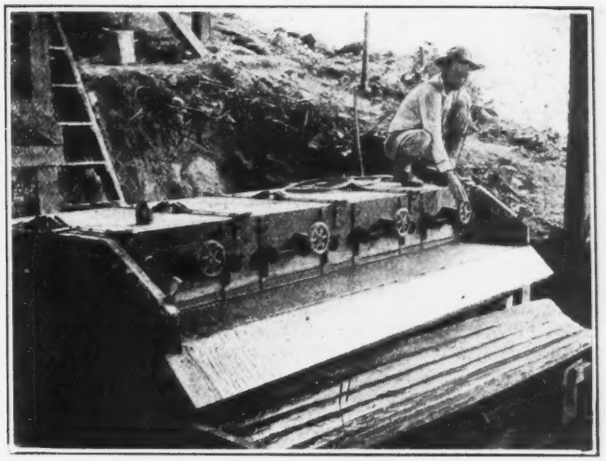
Two 5 by 7-ft. Straub crushers deliver the ore into the bin, from which a Southwestern ore feeder supplies the mills. Primary and secondary grind-



A mahogany mine timber
Much timber is required in the old La Cucaracha shaft



Straub crushers over the mill ore bins



K. & K. flotation machine at the new mill

ing is done by a pair of 4½ ft. by 16-in. Hardinge ball mills, using manganese steel balls. A Dorr simplex classifier returns the oversize pulp to the second mill for regrinding. Recoveries are principally by flotation, and pulp must screen 100 mesh. All oils for the flotation process are fed into the fine grinder, which provides for their thorough emulsification before entering the flotation machine. The flotation unit is a K. & K. machine, and is a recent model which discharges the concentrates from both sides simultaneously. The concentrates are drained, roasted bone-dry, in a furnace, and sacked in new canvas bags for shipment.

Wages paid Mexican mine workers range from 1½ pesos for unskilled labor, to 3 and 4 pesos per day for machine miners, mechanics and mill operators.

Climatic conditions obtaining in the district are healthful and favorable, and work may be carried on throughout the entire year. The favorable location of the mines, together with abundance of timber, fuel and water, and the peaceful and willing labor are elements which combine well with the quality of ore available, and have served to put this property on a profitable basis within less than one year from the start of organized company operations.

New mill of La Corona Mining & Milling Co. at Yago

Lessees at Gilbert Ready to Work With Milder Weather

Progress at Gilbert, the new bonanza gold camp 29 miles west from Tonopah, Nev., has been slow, owing to extreme cold weather, making surface work almost impossible, and to lack of suitable living accommodations.

Little work has been accomplished on the main strike during the past month. The shaft is 26 ft. deep, and the crosscut from the bottom of the shaft about 40 ft. long. To the west the limit of the ore appears to have been found, but to the east the crosscut still shows values. Suitable camp buildings, hoist machinery, and shaft timbers have been purchased from an inactive Divide district property, and are being moved to the new camp preparatory to starting a new shaft.

About twenty leases have been assigned and several sets of leasers are already engaged in surface trenching, with many others ready to begin work as soon as weather conditions permit.

Leadore Company Gets Additional Property in Idaho

Recent developments have added 50,000 tons of lead-silver ore in the Leadore mine at Leadore, Lemhi County, Idaho, according to a report by J. L. Magney, vice-president and general manager.

The Leadore Mining Co. has acquired the Leadville and Kimmel mines, adjoining properties, and has been carrying on systematic development in the properties for several months. It is claimed that 400,000 tons of mill ore has been opened in the two mines, and a set of rolls, flotation cells and classifier will be added to an old mill on the property which will give a capacity of 100 tons daily. The plans are to use the remodeled mill as a pilot mill in working out a treatment for a larger plant.

Cleveland-Cliffs Expands Mining Operations in Michigan

The ten mines operated by the Cleveland-Cliffs Iron Co. in Michigan have changed their working schedule from four to five days per week. It was early in the summer when the reduction was made from full time. This company is carrying large stocks of iron ore at its mines, but the outlook for 1925 is encouraging. It is thought that a full-time basis will be in effect before navigation opens in the spring.

Boston & Montana Property Will Be Sold

At the instance of the New England Trust Co. the Boston & Montana property, consisting of mining claims, and mill, situated in the Elkhorn mining district in Montana, has been advertised for sale. The sale is set for Jan. 19 at 2 p.m. and will be conducted at the office of the company, at Cooldige, Beaverhead County, Mont. Attorney W. D. Kyle, of Butte, who has been appointed master in chancery, will conduct proceedings.

All of the company's property, including the railroad, will be sold. Bidders will be required to post a forfeit of $50,000 five days before the sale as evidence of good faith. No bids of less than $100,000 will be accepted.

It is reported that a new company has been organized by W. R. Allen, who originally promoted the company that developed the property, to bid in the assets. If he is successful, he says, operations will be resumed at once.

Proposed Railroad in Mexico May Help Mining

Engineers are now at work surveying the proposed railroad in Sonora, Mexico, connecting Port Yavaros with the Kansas City, Mexico & Orient line, according to advices received in Nogales. A complete preliminary survey of the proposed rout will start at Port Yavaros and pass through Alamos, Navojoa, and Uruachic to join with the main line of the Kansas City & Orient R.R. Potential mining country will be opened.

Star Oreshoot Shows 12 Per Cent Zinc and Lead

Zinc Predominates in 20-Ft. Vein at Present Face—Approach Morning Line

The orebody struck at the 4,100-ft. depth in the Star mine of the Sullivan Mining Co., in the Coeur d'Alene region of Idaho, has a width of 20 ft. near the face. This is comparable with a width of 10 ft. soon after the strike a month ago.

Ore has been continuous, except for some pinches, throughout the length of the drift, which has been advanced 300 ft.

Zinc predominates at present by comparison with a lead predominance farther back in the drift. The ratio has varied as the work proceeded. Ten feet at the face is reported to contain 12 per cent lead and zinc.

Drifting may proceed for a long distance before the end line of the Morning mine of the Federal company is reached, the distance from the point of the first ore disclosure to the Morning line having been 1,650 ft. The ground above the 4,100 level, probably 2,000 ft. above, has been opened sufficiently to establish the continuity of ore for a long distance in that direction and the existence of ore at the 4,100-ft. depth suggests its continuance below that horizon.

Mainly out of the same vein in the Morning mine the Federal Mining & Smelting Co. has disbursed many millions in dividends. The Star mine of the Sullivan company is owned jointly by the Bunker Hill & Sullivan Mining & Concentrating Co. and the Hecla Mining Co., and is reached through a 9,000-ft. crosscut driven from the 2,000 level of the Hecla mine. Ore broken in the course of drifting has been proceeding from the Star to the south mill of the Bunker Hill at Kellogg, Idaho, at the rate of a carload a day.

Flowery Comstock Milled 9,300 Tons of Gold Ore

Bullion tax reports of the Flowery Comstock Mines Co., operating a gold property three miles east of Virginia City, Nev., show that during the third quarter of 1924 this company produced 9,300 tons of ore, on which a net profit of $41,850 was realized. The ore averaged $7 per ton in gold and extraction was 98 per cent by cyanidation, according to the management.

The Flowery Comstock was organized by R. A. Hardy and Alex. Wise, two well-known Nevada mining engineers and operators, and they are now personally directing mining and milling operations. The 200-ton cyanide plant was completed in late July and regular operations started at about that time. Early reports indicated the presence of 130,000 tons of $7 ore available and if the tonnage estimate is confirmed by production, the company has a profitable period ahead. Both mining and milling costs are abnormally low, as the reported costs for the third-quarter period, a total of $23,250, would indiperiod, totaling only $23,250, would indicate.

New Ore in Calumet & Arizona's Junction Mine

Developments on the 2,200 level of the Junction mine of the Calumet & Arizona Mining Co. at Bisbee, Ariz., have opened a body of ore, 500 ft. northeast of the Junction shaft, which gives every indication of being a large and valuable find. A drift has entered the ore, which is also exposed by two crosscuts, and the face shows 15 ft. of ore, assaying 15 per cent copper. Other portions of the new orebody carry better than 7 per cent. This find will be of great assistance in maintaining the grade of mine production.

Arkansas Manganese Mines Produced 11,000 Tons in 1924

Small Operators Most Successful—Large Washers Were Shut Down

The Batesville-Cushman manganese field, in northern Arkansas, during 1924 produced about 5,500 tons of low-grade ore, and 5,800 tons of high-grade. The former average 30 per cent and the latter 55 per cent.

A good many small operations were carried on in the field, approximately 200 men being employed steadily during 1924. The Northern Minnesota Ore Co. produced practically all of the low-grade ore shipped, from its Aydelott mine, near Cushman. Walter Denison and Tom Shell were the largest producers of high-grade.

Several large operations were started in the field early in 1924, but after a few months' operation closed down. These mines were equipped with washing plants, built to handle a large tonnage.

The small operations were generally successful and operated continuously throughout 1924. Most of these smaller properties were worked with pick and shovel for the boulder ore. Some were equipped with small washers that successfully handled the wash dirt left after the boulder ore was hand picked. These plants consist of a revolving screen and hand jigs. The screen is operated with a small gasoline engine. Many of the properties were worked by contract.

The future of the field depends on the continuance of the present tariff. Without the tariff, operations would have to be discontinued. From observations extending over a decade it seems that the production can best be increased by adding to the number of small operations.

Candelaria Mill Restarts

The mill of the New Candelaria Mines Co. at Candelaria, Nev., is operating regularly, treating around 100 tons of silver ore per day. Part of this ore is sorted from stope fills and a part is produced from the mine.

Several new finds have been reported which may develop into orebodies of importance, one of them to the north of a large fault and in virgin territory. Results of operations are not available at present. The company is a reorganization of the old Candelaria Mines Co.

Expect No Large Increase in Michigan Copper Output

Large Additional Forces Would Be Necessary—December Output 10,800,000 Lb.

In spite of the better demand for copper and advance in the price of the metal, no very large immediate increase in production may be expected from the Michigan district. All of the producing mines are well opened, far in advance of possible requirements, and underground organizations are efficient. This will make possible some increase in production, if necessary, but any substantial increase will be dependent on the ability of the mines to add to their forces sufficiently to enable them to reopen additional shafts or attack reserves. Calumet & Hecla Consolidated is in better position to enlarge production than any of the other producers. It can put its new Tamarack reclamation plant into operation and increase both Ahmeek and conglomerate outputs with only a comparatively small expansion in its labor forces.

December refined copper production in the Michigan district was 10,800,000 lb. The Calumet & Hecla Consolidated group produced 5,600,000 lb., Ahmeek contributing 2,600,000 lb., the reclamation plant, 1,300,000 and the conglomerate department 1,700,000. Mohawk's output was 1,600,000; Quincy, 1,000,000; Isle Royale, 750,000; and Copper Range, 1,850,000.

Owing to the resumption of operations in the Calumet branch of the conglomerate, Calumet & Hecla increased production in this department somewhat, although tonnage from the Calumet branch is not yet back to normal, on account of fire damage in No. 4 shaft. Copper Range production still is slightly below normal as a result of excess water difficulties but will soon be at the rate of 2,000,000 lb. per month.

Open Gold Prospect Near Long Lake in Manitoba

A promising gold prospect is being developed near Long Lake, Manitoba, by A. M. and H. J. Stewart. The property, called the Dardanells, was located by them in 1915.

Recently three veins carrying high gold values have been traced across the property from 1,000 to 3,000 ft. according to A. M. Stewart.

Assays from the surface to 35 ft. in depth over 3 to 4 ft. run $12 to $26; over 3 to 5 ft., $10.80 to $41; over 3 ft., $24.10.

An average sample from twenty-five tons of ore from which two tons of high-grade had been picked gave an assay of $26.36. The high-grade ran $336.

A mill run of 120 tons of ore gave an outturn of nearly $2,200 in gold.

A syndicate of Boston people has optioned properties to the north and south of the Dardanells group, and all ground between Long Lake and Bulldog Lake, about 5 miles distant, is now staked.

Big Increase in Cripple Creek Gold Production

GOLD production of Cripple Creek (Colo.) ores for 1924 exceeded in value that of any other year since 1918. The Golden Cycle mill treated 273,450 tons, with an average value of $17.33; and the Portland mill, 176,900 tons, of an average value of $4.84; together of an aggregate value of $5,522,871.80. The gross value of ore treated in 1923 was $4,161,306.21.

Arcadian Consolidated Has Funds for Development

The assessment of 50c. per share by Arcadian Consolidated, operating in the Michigan copper district, is being paid promptly, and the company is assured of sufficient funds for 1925 operations. The present program of development will continue without interruption. The new drift north from the 1,850 or bottom level of the New Arcadian shaft is opening good ground fully on a par with the values found in the 1,250 drift. Later in the year arrangements may be made to replace the hoisting plant at the New Baltic shaft which was destroyed by fire two years ago.

Kansas Explorations Co. Will Start New Mill Soon

The Kansas Explorations Co. plans to get its Isherwood mill, situated in the Smithfield section of the Joplin-Miami district, in operation early in January.

Two shafts have been completed to the 156-ft. level. A drift was started from one at 135 ft., but it was found this was not deep enough and the opening of the ground was set back somewhat on this account. However, it is believed the property will be in condition to supply the new mill with plenty of "dirt" by the middle of January.

The company's Jarrett mill, which is north of the Vinegar Hill Zinc Co.'s Barr mine, west of Baxter, has been getting into a better run of ore than it had at first and is expected to become one of the district's leading producers.

Miami Copper Co. Proposes Employees' Benefit Plan

A plan has been suggested to the employees of the Miami Copper Co. by officials, whereby former employees and their families who are in destitute circumstances may obtain assistance through a proposed relief fund which the company intends to create.

The plan suggested is that each employee make a voluntary contribution of 25c. monthly to the fund, and the company has agreed to contribute an amount equal to the employees' contribution, for the purpose of creating a fund to take care of those who are in destitute circumstances. This, the officials of the company believe, will eliminate circulating subscription lists among employees, which have become burdensome, it is said.

Washington News

By Paul Wooton

Special Correspondent

Chilean Nitrate Producers Fear "Synthetic" Competition

Would Reduce Export Tax—Claim Iodine Helps Farmers—Artificial Products Not So Good?

Alarmed at last by the progress being made and likely to be made in the production of synthetic nitrogen, the Association of Chilean Producers, in addition to launching a pretentious research program and drive against the export tax, is setting out, it is understood, to convince the farmers of the world that Chile nitrate is superior for fertilizer purposes to the synthetic product.

Chile nitrate contains iodine. Synthetic products do not. The association apparently has just discovered that iodine has wonderful properties in stimulating plant growth. This will be one of the points on which claims of superiority will be based. There still is in the popular mind a belief that natural products are better than synthetic ones. It took a long time, for example, to convince consumers that artificial ice is as good as that harvested from the surface of ponds.

In connection with the claims being put forward as to the value of iodine as a plant food, it may be stated that the metallurgists and the dye makers in the United States would think very much more highly of the Chilean producers were they to recover more iodine and allow it to find its way into trade channels. While it may be that the profit for handling the larger volume would be no greater than that obtained from the artificial price level now maintained, the Chilean producers at least would be absolved of the charge of wasting a valuable raw material.

Assurance of Current Antimony Price Would Stimulate Output

The present movement of antimony from Mexico to the United States is coming largely from stocks held by the Republican Mining & Metal Co., which owns the Cookson smelter, at Wadley, in northern Mexico. This smelter is not being operated, although consideration is being given at this time to its opening. As this involves correspondence with the main offices of the company in Newcastle-on-Tyne, no definite plans to that end have been made.

Despite the widespread military activities in China, antimony has continued to come out. Exports have been reduced, but there is not yet sufficient assurance of continuity of present price levels to prompt active preparations in Mexico for the renewal of antimony production. In addition to the Republican Mining & Metal Co., the American Smelting & Refining Co. and the American Metals Co. are in a position to produce antimony. It is understood that Mexican antimony can be laid down in New York, duty paid, with a profit when the price is 12c. per pound.

Ore Weighing 2½ Tons Brought $80,000 at Leadville

A CHRISTMAS SHIPMENT from the Putnik lease, on the Ibex, at Leadville, Colo., as one of several of approximately the same value that have been made during the last year, and indicates the extraordinary richness of the ore uncovered by the lessees. The shipment consisted of about 5,000 lb. of ore, of an estimated value of close to $16 per lb. or about $80,000 for the lot. The ore was shipped to the Leadville plant of the A. S. & R. Co. to be screened and sampled. After sampling, the metallics were shipped to the United States mint at Denver, and the remaining ore was treated at the smelter.

Gypsum Deposits Near Winkelman, Arizona, to Be Exploited

A new $100,000 plaster manufacturing company, with a daily capacity of 100 tons of plaster. will begin operations in Phoenix, Ariz., about the middle of January. The organization is headed by Gilmore Goodland, of Phoenix, and a group of British associates. It will be known as the Phoenix Plaster Co.

The new company will secure its gypsum from the 4,000-acre deposit near Winkelman, which it has taken over. A crusher has been installed, and crushed rock will be shipped to Phoenix ready for the mill. The gypsum in the deposit is said to be comparatively clean and desirable for making plaster.

New Placer Diggings in Cariboo District

Captain George Eberton, John S. Edwards and Albert E. Robertson, former Klondike miners, have spent the last season in prospecting the old Cariboo camp, in British Columbia, and claim to have made the discovery of rich placer diggings at Horsefly Falls.

The gravel extends for some distance below the falls, and according to returns from the season's work will run from $10 to $17 per yard.

A special dredge worked by dragline will be installed the coming season. The dredge has been tested in the Frazer and Thompson rivers, and has been successful.

Castle Mountain Mines, Inc., May Build Concentrator

The Castle Mountain Mines, Inc., which is operating the Cleaveland mine, an old lead producer in Meagher County, Mont., is preparing plans for a 100-ton concentrator. The company is arranging to purchase the milling machinery of a near-by company, which with a few additions and a new building will be ample for present needs. A fair supply of ore has been proved.

London Letter

By W. A. Doman
Special Correspondent

Rich Ore in West Springs Silences Adverse Rumors

Found in Unprospected Territory—Reports Attributed to Speculators —Russian Situation Better

London, Dec. 23—For some time adverse rumors have been in circulation concerning the West Springs Mines (Rand), and the shares were out of favor. The rumors were attributed to speculators who had sold short of the shares. Although a kind of semi-official denial had been given, it had little effect. I now learn that ore of high gold content has been found on the other side of the Modder Dyke, a fairly considerable footage assaying up to 1,000 in.-dwt. This ore will yield high profits, and is much above the average grade of the mine. The view is that as such rich stuff has been found in a hitherto unprospected part of the property, the area as a whole will be found to be of a profitable character. It is, too, in the neighborhood of the Springs Mines, where also ore above the average is being opened up.

Some months ago I mentioned that a private syndicate had been formed to test some mineral deposits in Afghanistan. A group of London financiers provided the funds and dispatched a party of experienced engineers, the purpose being at a later date to form a public company. The engineers have now reported that the deposits are not commercially exploitable and the project has been abandoned.

The annual meeting of shareholders of the Burma Corporation, held in Rangoon, was a successful affair, and the prospects are described as most hopeful. Sir Robert Horne was present. A new member of the board is W. S. Robinson, who is connected with the mines and smelters of the Broken Hill (N.S.W.) field. This joining of forces will give the various companies concerned a virtual monopoly of the lead position in the East.

At the meeting of shareholders of the Russian-Asiatic Corporation, Leslie Urquhart made a most important speech on the position in Russia. It is clear that negotiations for the return of properties to their owners are still proceeding, and according to Mr. Urquhart there is the possibility that the Soviet authorities will approach his board for the resumption of activities. The Bolsheviks have evidently come to the conclusion that the destruction of capital was a mistake, for though at one time they regarded capital as a curse, they are now seeking funds in those countries where it has been possible to amass savings. Things certainly seem to be trending in the right direction, and a high tribute was paid to the members of the Committee of Finance who have done their best to balance the budget, and whose methods, according to Mr. Urquhart, are such that even the most pronounced capitalist cannot but admire them.

I learn that in the coming spring a French company will begin the exploitation of a manganese mine situated near the village of Béla, in the region of Varna (Bulgaria). The analyses of the specimens of the mineral, which have been made in France, have, it is said, given good results.

The tin position is again becoming distinctly strong, partly owing to reports that America is buying heavily and partly to the fact that the F. M. S. Government, under the Bandoeng Agreement, has sold 725 tons, leaving its stock now at the almost negligible figure of 587 tons.

Biggest Year Yet for South African Gold Mines

South African gold mines have experienced a most successful year, and the general opinion is that the industry was never more efficiently administered. Production has shown a steady increase, and mining operations in 1924 have broken all records with an estimated output of 10,300,000 oz. or a margin over 1923 of 300,000 oz.

Profits in 1924 are expected to be 25 per cent greater than those of 1923. Economies are being effected in the mines, labor has been placed on a higher plane of efficiency, and more modernized methods are being introduced.

The depletion of accumulated stocks of diamonds throughout the world has spurred the Kimberley diamond industry to greater activity.

United States S. R. & M. Co. Buys Gold Hill Arsenic Property

The United States Smelting, Refining & Mining Co. has purchased the property of the Toledo-Gold Hill Mining & Milling Co., the purchase price being given as $50,000. The property in the Gold Hill, Utah, district adjoins the Gerster mine of the United States company, and will, like that property, be exploited for its ores containing arsenic.

The American Smelting & Refining Co. has a long-time lease on the Western Utah Copper mine at Gold Hill, from which it is mining scorodite ores. The ores carrying arsenic in the Gerster property are arsenopyrite occurring in fissure veins. The scorodite ores of the Western Utah Copper occur in large masses as replacements of the limestone, near the monzonite contact.

Granby Bonds Zinc Prospect in British Columbia

The Granby Consolidated Mining, Smelting & Power Co. has bonded the Standard group of four claims, on McGarth Mountain, in the Alice Arm district of British Columbia, from Miles Donald and W. McLean, for $50,000. An extensive deposit of zinc ore has been opened by a series of short tunnels and open cuts.

In places the ore is almost clear sphalerite, assaying up to 48 per cent of zinc. The property is close to tidewater. Development is to be started as soon as weather conditions allow.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Associated Gold Mines of W. A. Plans To Split Interests

New Organization Will Handle Canadian Properties, Including Keeley and Vipond

Toronto, Jan. 3.— The Associated Gold Mines of Western Australia, which is the largest shareholder in the Keeley and Vipond companies, in northern Ontario, purposes to form two new companies, one to handle Canadian affairs and the other Australian, and to distribute the stocks of these companies among its shareholders. The present company will go into voluntary liquidation, and one share each of the par value of $1 in the Keeley and Vipond companies will be given for each four shares held by the Associated Gold Mines. A new company is to be formed in England, with the name of the Associated Gold Mines of Western Australia, with a capital of £120,000 of 600,000 4s. shares and all the assets of the present company in Australia and £15,000 in cash will be distributed to the new company in consideration of 595,364 shares of 4s. each, the new company to take over any liabilities of the present company in connection with its Australian assets. Another new company, to be known as the Associated Mining & Finance Co. Ltd., is to be formed with a capital of £300,000 divided into 750,000 shares of 8s. each and the remaining cash and other assets of the present company, including its holdings in the Keeley and the Vipond, will be transferred to the new company in consideration of 595,364 shares of 8s. par value, the new company to assume the remaining liabilities.

The effect of the reorganizations will be that each holder of 100 shares of 10s. par value in the present company will receive the following: 100 shares of 4s. each in the new Associated company, 100 shares of 8s. each in the new Finance company, 25 shares of Keeley and 25 shares of Vipond. This calls for a distribution of 150,000 shares each of Keeley and Vipond. The Huronian Belt Co. is a large shareholder of the Associated Gold Mines, but a considerable proportion of the shares will find their way into private hands.

The Vipond Consolidated Mines has secured control of the adjoining Inspiration property, at Porcupine, through the purchase of a block of shares. The Inspiration is capitalized at $2,000,000 and owns three 40-acre claims west of the Vipond. It is understood that this ground was necessary for the Vipond, to provide storage for tailings. The question of tailings disposal in the district is an important one, and last year the Hollinger paid a substantial figure for ground for the same purpose. The Dome Mines, at the other end of the district, is reported to have recently completed the purchase of several claims, and it is understood that these are also for tailings-disposal purposes. Included in these claims are the Porcupine Bonanza, Cartwright, and two Goldale properties.

Men You Should Know About

E. P. Mathewson was in Toronto early in the week.

S. H. Dolbear, of Thetford Mines and Montreal, is in New York for a week.

Pentecost Mitchell, vice-president of the Oliver Iron Mining Co., is at Santa Barbara, Calif.

B. M. Concklin, chief engineer of the Arthur Iron Mining Co., of Minnesota, is in Washington, D. C.

A. H. Smith, of Toronto, has resigned from the management of the Foley mine, in western Ontario.

Charles Brackin, mining engineer, of San Francisco, has been spending the holidays in Cleveland, Ohio.

W. G. Devereux, consulting engineer, is now with A. A. Housman & Co., 301 Montgomery St., San Francisco.

H. K. Masters, mining and metallurgical engineer, has established offices at 111 Broadway, New York City.

Joseph Clendenin, manager of the sales department of Guggenheim Bros., of New York City, is making a trip to Florida.

H. James has gone to Herb Lake, Manitoba, to make an examination of several properties owned by English interests.

G. R. Flynn, of Katalla, Alaska, is in New York City. He is interested in the development of petroleum lands in the Katalla district.

Clyde A. Heller, president of the Tonopah Belmont Development Co., has returned to Philadelphia after inspecting Tonopah operations for his company.

Marshall D. Draper, mining and metallurgical engineer, announces the establishment of permanent offices at Detwiler Building, Pershing Square, Los Angeles, Calif.

Arthur Curtis James, vice-president of Phelps Dodge Corporation, has been inspecting the company's properties in the Southwest. Mr. James is also a large shareholder in the Southern Pacific.

Major J. U. Sebenius, general mining engineer for the Oliver Mining Co., who has been under treatment in a hospital in Rochester, Minn., is convalescing and regaining his health in that city.

A. H. Burroughs, Jr., manager of Talache Mines, Inc., Talache, Idaho, spent Christmas in Santa Barbara, Calif., with his family. He will visit Mexico, returning to northern Idaho late in January.

M. J. Conover, formerly field engineer for the California MacVan Co., of Sacramento, Calif., is now general manager for the Shamrock Mines Co., operating at Ione, Nev., with company headquarters at Salt Lake City.

Donnelly Keresey, of the wire mills department of the Anaconda Copper Mining Co., according to a recent announcement, is to marry Mary Dorothy Kelley, daughter of C. F. Kelley, president of the Anaconda company.

M. F. Fairlie, manager of the Mining Corporation of Canada at Cobalt, Ontario, was compelled to undergo a surgical operation at the Mayo Clinic, at Rochester, Minn., on Dec. 17 last. He is now making a good recovery.

Earnest Blanck, of Los Angeles, Calif., is in New York in connection with negotiations for the sale of the California Rand silver mine, of which he is a large stockhohlder. The mine is under option to Eastern capitalists.

Lloyd L. Root

Lloyd L. Root, California State Mineralogist, has returned to San Francisco from Spokane, Wash., where he represented Californian mining interests at the Northwestern Mining Convention. While in Spokane, Mr. Root was also a speaker-guest at a luncheon given by the local section of the Institute.

George L. Oldright, hydrometallurgist of the Salt Lake station of the U. S. Bureau of Mines, has left Salt Lake for Tucson, Ariz., where he will devote about a month to the study of copper metallurgy at Arizona's leading copper properties.

A. S. Winther has resigned as manager for the United Comstock Mines Co. and has removed to San Francisco. The United Comstock is now the property of the Comstock Merger Mines Co. and will be handled by the officers of that organization.

Elmer E. Paxton has been elected president of the California Metal & Mineral Producers' Association for the ensuing year. Other appointments include: **P. C. Knapp,** first vice-president; **E. C. Hutchinson,** second vice-president; **Arthur B. Foote,** third vice-president; **Robert I. Kerr,** secretary-treasurer.

John E. Penberthy, mining engineer, who has been prominently identified with copper mining in the Southwest for the past twenty years, and more recently with the Moctezuma Copper Co., a branch of the Phelps Dodge Corporation, has resigned from the above-named company. He is now in Phoenix, Ariz.

W. C. Browning, for twelve years general manager of the Magma Copper Co. operations in the Superior mining district, has retired and **William Koerner,** who has been assistant general manager, has been appointed to act as general manager. Mr. Koerner came to Superior last May from Nevada, where he was connected with the same company.

H. W. Edmondson has returned to Chihuahua, Mexico, from California, where he spent a short Christmas vacation. Mr. Edmondson is operating the Rio Plata mine near Guazapares, with a payroll of about 250. He reports much poverty in the outlying districts, with a tendency toward stability in mining development. Funds are not available for filibustering expeditions, and it is becoming increasingly evident that rehabilitation will depend to a considerable extent on United States participation in Mexican mining enterprise.

Obituary

Carlton Harper Hand, a well-known mining engineer, died at his home in Los Angeles on Dec. 24 last after a few days' illness. He leaves a widow, one son, Arthur, and one married daughter, all of Los Angeles. Mr. Hand was born at Portage, Wis., and was graduated from the Colorado School of Mines about forty years ago, later acting as instructor in assaying and chemistry at that school, which he left to take his first engineering position at the Black Hawk mine, in New Mexico, where he remained for several years, and after which he moved to Montana, forming an association with the interests of A. W. McCune, of Butte and Salt Lake City. In 1898 he was appointed general manager of the Payne mine, in the Slocan district of British Columbia. Seventeen years ago he removed to Los Angeles, and he had since that time been in general consulting practice, having visited professionally most of the important mining districts of the Southwest and Mexico, making examinations also in South America. His experiences in the high elevations of the Andes seriously affected the robust health that Mr. Hand had previously enjoyed.

William Slemmer, prospector, was found dead on a lonely mountain trail in Shasta County, Calif., on Dec. 19. Old age, poverty, and isolation marked the end. By trade a printer, Slemmer long ago was attracted by the lure of the hills. He did well. The sale of the Keystone mine to the Mammoth Copper Mining Co. netted him $12,000. Then he married, and the money disappeared. A return to prospecting resulted successfully, and a sale made him the possessor of another small fortune. This went, too. Illness supervened, and the county hospital was his home for awhile. Finally, the curtain was rung down on a tragedy of want and loneliness.

Societies, Addresses, and Reports

The Business Side of Black Jack Zinc Mining

W. R. Wade Describes Difficulties of Miner in Practical Talk to M. I. T. Students

TAKING "Some of the Problems of the Black Jack Zinc Miner" as his theme, W. R. Wade, formerly manager of the New York Zinc Co., at Edwards, N. Y., recently delivered a lecture to the students at the Massachusetts Institute of Technology. Beginning with a brief survey of the zinc industry of the United States, he said that practically three-fifths if not four-fifths of zinc produced in the United States comes from the Tri-State or Joplin-Miami field. "The ores in this field are very simple metallurgically," he said. "They have practically only three minerals — galena, sphalerite, and cherry limestone. The zinc predominates over the lead, to the extent of six to one. These sulphide minerals occur as big coarse crystals, and break free from the rock gangue with comparatively coarse crushing. The low-grade ores can thus be easily concentrated without fine grinding, by a cheap, simple, gravity, concentration process. This coarse crystallization and the difference in specific gravity of the sulphides permits the Joplin miner to produce clean high-grade zinc and lead concentrates. The lead is really a by-product with these mines, but of considerable importance, as in 1924 it accounted for about one-third of the cash receipts.

"The sphalerite of the Tri-State field is yellow rosin jack. You may think that the color can have no important bearing on the business department of zinc mining, but it has indirectly a very important bearing. Chemically pure zinc sulphide should be white. Rosin jack is very nearly chemically pure, and assays about 67 per cent metallic zinc. The result is that the Joplin miner not only can but does produce a zinc concentrate that carries 60 to 61 per cent zinc; also, his concentrate generally has less than 1 per cent iron, less than 2 per cent lead, and less than 2 per cent lime.

"Now, as the Joplin field is our greatest source of zinc and has been such for a great many years, and as coal, fireclay, natural gas, and other things necessary for smelting zinc ores occur in Kansas, Illinois, and Oklahoma, not far from this great zinc field as distances go, it is only natural that a great zinc-smelting industry has in time been built up, drawing on Joplin for its ore supply. I am going into this point of the Joplin field and the smelting industry based on it because it has established the standards on which all other zinc smelters in the United States buy zinc ores, and all other zinc smelters in this country must exist in competition with the smelters drawing their ores from Joplin.

"The base on which Joplin concentrates are sold is as follows: Base 60 per cent zinc; under 2 per cent lead; under 2 per cent iron; and under 2 per cent lime; concentrates to be fairly coarse granular material, not fines, slimes, or flotation.

"The smelters send representatives to the mines each week and buy the week's production in the mill bins. Neither the smelters nor the miners appear to want to contract their output for a period of time, but both apparently appear willing to take their chances, making a trade for the concentrates each week. The price paid for concentrates naturally varies with the price of metallic zinc, but it does not always rise and fall in true ratio. There are times when, owing to shortage of concentrates and a firm position of the miners, the smelters are forced to pay more than the concentrates are really worth to them; then again the reverse is true and the miners receive less than they should for their concentrates.

"*Mining Journal-Press* publishes each week the price of Prime Western zinc at East St. Louis. This is the principal grade of slab zinc made from Joplin concentrates. You will also notice on the next page generally the Joplin market for zinc and lead concentrates. I have taken the market ending the week of Nov. 15 this year to illustrate the business points I wish to make this evening. I quote the market as follows:

"First the slab zinc market East St. Louis zinc averaged for the week 6.88c. per pound. Second, the Joplin market for concentrates 60 per cent base: Premium grade, $47 to $48; Prime Western grade, $46 to $47; fines and slimes, $42 to $43; average price all grades $45.30; shipments for week, blende, 16,860 tons; lead, 3,151. Value of all shipments for week, $1,132,690.

"These Joplin prices mean this, that jig concentrates containing 60 per cent zinc, less than 2 per cent of iron, lime, or lead, sold for $47 to $48 per ton, in the mill bin, the smelter paying the freight to his plant. The concentrates are Prime Western grade unless they are exceptionally low in lead, 0.2 per cent or under, when they become premium grade. If the concentrates are above 60 per cent or below 60 per cent, it is the Joplin custom to add or subtract $1 for each per cent of zinc above or below grade; also, a penalty of $1 per unit is imposed for iron, lime, or lead over the 2 per cent allowed.

"The smelters today are used to 60 per cent concentrate, low in iron and granular in form. There appears to be available an abundant supply of such concentrates, and the supply should continue for many years to come. At times in the past the Tri-State field has had to shut down one to three days each week to keep down the surplus of unsold concentrates.

"Now we come to the poor miner whose ore is black jack. Here are some of his troubles: First, he is probably a long way from a zinc smelter and has a high freight rate. He will naturally have to pay the freight on his concentrate to the smelter. Second, his ore is probably a fine-grained crystalline structure that cannot be concentrated by simple gravity methods with comparatively coarse crushing only, but requires fine grinding and probably flotation. Right here he gets his first jolt. Flotation concentrates are penalized $3 to $5 per ton because of their finely ground condition, but that is not the worst of it. The fact is that most of the zinc smelters do not want them at all, or at most in limited amounts. There is probably one good valid reason for this, and that is that many zinc smelters produce sulphuric acid as a byproduct and the flotation concentrates produce an excessive amount of dust in the roaster gases, which causes trouble. Also, most flotation concentrates carry 12 to 16 per cent moisture, and this puts a heavy drying cost on the smelter.

"Third, he cannot produce a high-grade concentrate, that is to say assaying 60 per cent or better, because his black jack crystal contains so much iron and other impurities that the clean black jack crystal will not assay over 55 to 58 per cent in most cases. His commercial concentrate, do the best he can, will not run much over 52 per cent, probably be nearer 50, and contain 8 to 10 per cent iron.

"To illustrate what these facts mean in dollars and cents let us assume the black jact mine is in Arizona, and that it produces a 50 per cent flotation concentrate, containing 9 per cent iron, some lead in the concentrate but under 2 per cent, and lime under 2 per cent. The concentrates are to be shipped to a Kansas or Oklahoma smelter. The freight rate will be about $8 per ton. Figured on the price of Joplin concentrates here is what his concentrate was worth on board cars in Arizona, November, 1924.

60 per cent base $47.00	For 50 per cent deduct	$10.00
	For 9 per cent iron deduct	7.00
	For flotation concentrates deduct	3.00
	For freight deduct	8.00
	Total deductions	$28.00

Net remainder $19 per ton.

"Now, our Western black jack miner received $19 for his 50 per cent concentrates, whereas the Joplin man got $47 for his 60 per cent concentrates. Figured by the unit value—that is, the value for each per cent of zinc, or per 20 pounds—the Joplin man got 78c. per unit, and the Western black jack miner, 38c. per zinc unit.

"Probably the Western miner has a contract with the smelter, and if so it will be about on the following terms: When zinc is 5c. for Prime Western grade, East St. Louis, we will pay at our smelter for 50 per cent base $25 per dry short ton. Unit variation 80c. per unit up and $1 per unit down to apply to the base price, if the ore is above or below the base of 50 per cent. Market variation, when zinc is above 5c. and up to 7c. per pound, 70 per cent of the increase shall be added to the base price and when over 7c. up to 10c. 60 per cent of such increase from

7c. Penalties: Iron, lime and lead over 2 per cent at a dollar per unit. Fines and flotation concentrates penalized $3. This figures out as follows:

Zinc for week Nov. 15 was 6.88c.		
50 per cent concentrates base		$25.00
Price increase 1.88 times 0.70 times 1,000 lb. metallic zinc in concentrates, add		13.16
Base price 50 per cent on 6.88c. market		$38.16
Deductions		
Iron 9 per cent	$7.00	
Freight	8.00	
Flotation	3.00	
	$18.00	
Net value concentrates to shipper		$20.16

This is $1.16 more than the Joplin scale would figure, but we must remember the shipper pays freight to the smelter and it costs the smelter about $2 to $3 to get the Joplin ore to his plant.

Iron in the Sphalerite the Chief Trouble

"The biggest trouble the black jack miner is up against is the iron in his sphalerite crystal. It prevents him from making a high-grade concentrate, and he has to pay heavy penalty for the iron at the smelter. The smelter is justified in this iron penalty, as the iron decreases his retort yield and increases his costs.

The Solution

"What is the solution of the problem for the black jack miner? How can he get a fair price for his zinc units? The answer is not to send it to the Belgium retort plant in competition with Joplin ores, but to turn it into some other zinc product. The most promising of these are zinc oxide and lithopone.

"Zinc oxide is generally made on a Wetherill grate. The iron in the black jack causes no trouble, and generally up to 10 per cent is allowed free. Also, it is not necessary to have such high-grade concentrates, as 30 to 45 per cent is good feed for an oxide plant. Here we get up against another difficulty with our black jack, as good zinc oxide must be free from lead. It must be snow white and have a minimum of soluble sulphates in it. To make such oxide the ore feed on the Wetherill grates must be lead-free; that is to say, the lead must be down to about two-tenths of 1 per cent in a 45 to 50 per cent concentrate. Very few mines in this country can produce such concentrates. To produce lead-free concentrates the mine ore must have practically no lead in it.

"You may think that it should be possible to separate the lead and zinc in ores where the two metals occur. It is possible to do so to a certain extent, but not to the limits called for in lead-free concentrates. If the mine ore has only a few tenths of 1 per cent lead, unless great care is taken the zinc concentrates are sure to be too high in lead to be classed as lead-free, and if the ore has 2 per cent or more lead, it is impossible with any of the present concentrating equipment to keep the lead low enough in the zinc concentrates.

"There are deposits in the United States where the zinc ore is free from lead, and such deposits are of great value. The ores from these deposits will make high-grade white oxide and also will make very high-grade slab zinc. The principle deposits of lead-free ore with which I am familiar are the Franklin Furnace mine, the Mascot mine, and the Edwards mine.

"At Franklin Furnace the ores are silicates and oxides of zinc mixed with oxides of iron and manganese. The zinc silicates are made into a concentrate running 40 to 45 per cent zinc, low in iron, and smelted in Belgium retorts. It yields premium slab zinc, which commands 1 to 2c. over the market price. The iron, manganese, zinc oxide is made into another concentrate by itself and it is too low in zinc and too high in iron for the production of slab zinc in the retort, but it is good oxide material. Because it is lead-free it produces wonderful oxide.

"The Mascot mine has a rosin jack ore, and it is lead-free. The concentrates are made by flotation, but the company owns its own smelter. The ore is made into oxide, as it is the most profitable use for it, but it will also make high-grade zinc.

"The Edwards mine interests us greatly because here is a black jack ore. These ores are an intimate mixture of black sphalerite, iron pyrite, and serpentine limestone. The mine ore contains only one-tenth of 1 per cent lead and often less. Ordinary gravity concentration produces a mixed zinc and iron sulphide concentrate running about 30 per cent zinc. A magnetic process cleans this up to a 45 to 50 per cent zinc concentrate, and an iron pyrite concentrate that is sold to the acid burners for its sulphur.

"The zinc concentrate is sold free from iron penalty when the iron is under 10 per cent, and this is about the average iron in the concentrates. The concentrates are lead-free and as such produce fine oxide. They receive a very nice premium because of this lead-free feature. Their lead content is generally under one-tenth of 1 per cent. To sell these concentrates against Joplin ore for the production of Prime Western zinc they would bring around 50c. per zinc unit on the same market, namely 6.88c. zinc. The reasons they bring more than our Western example is the lower freight rate and the fact they are not flotation concentrates.

"Let us consider the ordinary black jack deposit, especially those in the West. The ores are generally high-temperature or intermediate-temperature deposits and consist of an intimate mixture of several sulphides—namely, lead, zinc, iron, and often copper. Arsenic is often present. If the principle sulphide is black jack zinc, the question is what can we do to make it into a commercial product that is going to be profitable. Gravity concentration with magnetic separation will probably yield a 45 to 47 per cent concentrate with 5 to 8 per cent lead and 7 to 10 per cent iron. Flotation will raise the grade to say 50 per cent, but still have 3 to 6 per cent lead and say 6 to 7 per cent iron. The retort smelter will not buy such ore at a decent price. It has too much iron and too much lead. If the concentrates are flotation they are even less popular.

"A second-rate oxide can be made from such ore. It is a leaded oxide, and the market is not as good for it as for lead-free oxide, but there is a market. The price is half to a cent a pound lower. The oxide plants that make this kind of oxide are not paying fancy prices for such ores, as they know they are hard to sell.

"An electrolytic plant can make good high-grade slab zinc from such concentrates, but such plants are not generally available. The Anaconda plant at Great Falls is about the only one in the United States running at present. Such plants take a very heavy investment and are only warranted where there is cheap hydro-electric power and an ore supply that will last for a very long time.

Lithopone Demand Increasing

"There is a white pigment known as lithopone which is composed of zinc sulphide and barium sulphate. These leaded zinc concentrates could be made into lithopone at the mine, provided the ore supply justified the erection of such a plant. The demand for lithopone is increasing very rapidly. It commands a good price. It is used not only as an interior white pigment but in the rubber industry, in printer's ink, and many other industries, and is replacing zinc oxide for many uses.

"It must be borne in mind that lithopone has only about 25 per cent metallic zinc. Moreover, unlike white oxide, it can be made from all kinds of smelter dross, blue powder, and scrap. The market probably could not absorb all the lithopone that could be made from the zinc concentrates of a big zinc mine if it was put on the market suddenly, but it is a business that could be built up.

"I hope I have made it clear to you that the black jack mine is up against some very serious problems when it comes to competing against the Joplin concentrates. The Western mine generally has a leaded black jack ore, finely crystalline, and a high freight rate. The zinc concentrates from such a mine are not going to net much over half as much per zinc unit as the Joplin concentrates. This means that a black jack ore in the West to be profitable must be rich in zinc and occur in big, cheaply minable orebodies. The same thing is true in the East. If the black jack is free from lead, that is another story. I would say as a general proposition that no Western zinc mine could make money unless its ore ran 18 to 20 per cent zinc, while a Joplin mine can do very well on ore that runs 6 per cent metallic zinc."

Spokane Engineers Select Head

Frank M. Smith, director of the Bunker Hill & Sullivan smelter, and well known as a metallurgist, has been nominated president of the Associated Engineers of Spokane, Wash., for 1925. The Associated Engineers is an organization consisting of members of the American Institute of Mining & Metallurgical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Electrical Engineers and Architects.

Geological Society Holds Meeting at Ithaca

The Geological Society of America held its thirty-seventh annual meeting at Cornell University, Ithaca, N. Y., Dec. 29, 30 and 31. The Mineralogical Society of America and the Paleontological Society met at the same time and place. The meetings were held in Baker Hall, and visiting geologists were cordially welcomed in a felicitous speech by President Livingston Farrand of Cornell. The presidential address of the retiring president, Waldemar Lindgren, on "Metasomatism," was delivered Monday evening. The retiring president of the Mineralogical Society, Dr. Henry S. Washington, made his presidential address on Wednesday noon, the subject being the "Modern Study of Minerals." President Berry of the Paleontological Society gave his address Monday noon, on "Correlation."

The annual banquet was held on Tuesday evening in Risley Hall. Prof. James F. Kemp was toastmaster. The occasion was taken by the Society of Economic Geologists to present its gold medal, founded by Dr. Penrose, for "Distinguished Contributions to the Earth's Sciences," to the veteran geologist, Prof. Thomas Crowder Chamberlain, of Chicago University, well known for his glacial studies, for his textbook (with Prof. Salisbury), and especially for his promulgation of the Planetesimal Hypothesis of the earth's origin. Professor Chamberlain came to Ithaca to receive the medal, but slipping on the steps of Baker Hall a day or two before, he was injured sufficiently to be confined in the hospital at the time of the presentation, although his injuries were relatively trifling; so that he deputized a brother professor to receive the medal for him.

It was announced that the Society of Economic Geologists had elected as its president for 1925 Prof. C. K. Leith, of Wisconsin; as vice-president, Arthur C. Spencer, of the U. S. Geological Survey; as secretary, Sydney H. Ball; as treasurer, J. Volney Lewis.

Sixty papers were listed for presentation before the Geological Society of America, at Ithaca; sixteen by the Paleontological Society; and twelve by the Mineralogical Society of America. The Society of Economic Geologists did not hold any technical meeting, reserving that for its annual May meeting. Most of the papers mentioned above as listed for presentation were actually presented. They covered, as usual, a broad field of geological inquiry, and were of varying degrees of excellence and of interest. This description, which is safe for any society meeting, is especially safe in the case of the meeting of the Geological Society of America. It would be manifestly impossible to give even a faint idea of the subject matter of the ninety papers presented; but it would certainly seem that geologic science next year must be on a quite different basis from what it was last year—otherwise, many will have bled in vain.

The incoming president of the Geological Society of America, Professor Scott, of Princeton University, was prevented from attending the sessions.

J. E. SPURR.

Recent Technical Publications

Reviews, Abstracts, and References

The Use of Charts

Graphic Statistics in Management. By William Henry Smith. Published by McGraw-Hill Book Co., New York. Price $4.

This volume goes a step farther than the usual book relating to the construction and use of statistical charts and diagrams. It does not stop with a description of the tools which are at the disposal of the statistician in displaying his work to best advantage, but takes up the interpretation and use of statistical information which business men find useful in the conduct of their enterprises. In other words, the graphs are given practical application to various industries. The author frequently gives his reasons for the selection of certain data as a good statistical guide, but lack of space naturally precludes an extended discussion of this subject. Such topics as the graphical analysis of markets, sales, production control, advertising, accounting, costs, production, purchasing, and organization receive treatment in a simple straightforward manner. The text is profusely illustrated. Anyone interested in statistical methods will find much of value in the book.

Canadian Geology—Summary Report, 1923, Part A, of the Canadian Geological Survey, Ottawa, pp. 114, obtainable on request, contains the following papers: "Geology and Ore Deposits of Keno Hill, Mayo District, Yukon," 21 pages, by W. E. Cockfield; "Silver-lead Deposits of Beaver River Area, Yukon," 7 pages, by W. E. Cockfield; "Reconnaissance Between Skeena River and Stewart, B. C.," 17 pages, by George Hanson; "Reconnaissance of Silver Creek, Skagit, and Similkameen Rivers, Yale District, B. C.," pp. 35, by C. E. Cairnes; "Hillsbar Gold Group, Yale District, B. C.," three pages, by C. E. Cairnes; and "Platiniferous Rocks From Tulameen Map-area, Yale District, B. C., and Ural Mountains, Russia," 18 pages, by Eugene Poitevin.

Mine Ventilation—In the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for September, H. Pirow has a 42-page paper, supplemented by an extended bibliography, on "Underground Conditions Liable to Affect the Health of Workers in Gold Mines on the Witwatersrand." Price 3s. 6d. from the society at Johannesburg.

Air Lift—Vol. IV, No. 2 of the technology reports of the Tohoku Imperial University, Sendai, Japan, contains an 18-page paper on the "Theory of the Air-lift Pump, With Special Reference to the Slip of Air Bubbles in Water," by Otogoro Miyagi. The discussion is purely theoretical. The bulletin is for sale by the Maruzen Co., Ltd., Tokyo, Japan; price not stated.

Gold Coast Mining—A report of the mining industry of the Gold Coast for the period January, 1922, to March, 1923, is available for 2s. from the Mines Department, Tarquah, Gold Coast, Africa.

Ontario Mining — Vol. XXXII, Part III, of the thirty-second annual report of the Ontario Department of Mines, Toronto (38 pages, obtainable on request), contains the following reports: "Geology of Base Line Running West From Near Mile 19, Western Boundary of the Nipigon Forest Reserve," by W. F. Green; "Geology of Certain Base and Meridian Lines West of Lake Nipigon," by W. L. Swanson; and "Kenogamissi Lake Area, Including Townships of Denton and Keefer," by E. W. Todd. The last-named district has been mapped in colors.

Lead Smelting — "The Bunker Hill Smelter" is the subject of a descriptive article by Frank M. Smith in the Dec. 1 issue of *Mining Truth* (Spokane, Wash.; price 25c.). Many other mining properties of the Northwest are also reviewed in this special issue, published for the twenty-ninth annual Northwest Mining Convention.

Bonding Refractories — In *Chemical and Metallurgical Engineering* for Nov. 3 (New York; price 25c.) is a short article by R. C. Gosreau on "Bonding High-temperature Refractories," which gives a table of satisfactory binders for high-temperature refractories, and also a table of refractory bonds and mixtures and burning conditions.

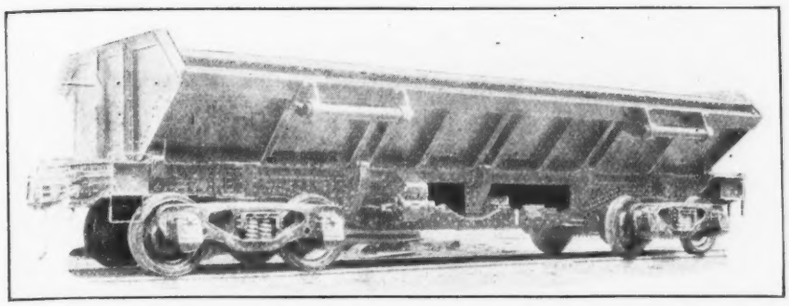
Cyanide Process—U. S. Bureau of Mines *Reports of Investigations* No. 2,648, obtainable on request, is a seven-page discussion by E. S. Leaver, C. W. Davis, and J. A. Woolf, on the use of "Calcined Dolomite as a Substitute for Lime in the Recovery of Gold and Silver by the Cyanide Process." For certain ores, the substitution may be made with profit.

Metal Statistics—The 1924 report of the Metallgesellschaft, Frankfurt am Main, Germany, is now available, with the customary data on production, consumption, and prices of aluminum, lead, copper, nickel, quicksilver, silver, zinc, and tin. Since the publication of statistical reports by the American Bureau of Metal Statistics, the Metallgesellschaft bulletin is of secondary interest to English-speaking readers.

British Columbia Geology—Memoir 139 of the Geological Survey, Ottawa, Ont., 187 pages, with colored maps, is a geological report on the "Coquihalla Area, British Columbia," by C. E. Cairnes. Obtainable on request.

Western Australia Mining—Bulletin No. 89 of the Geological Survey of Western Australia, Perth, 119 pages, discusses "The Geology and Mineral Industry of Western Australia." It is by A. Gibb Maitland and A. Montgomery.

Oxygenated Air in Metallurgy—A symposium on the use of oxygenated air in metallurgical operations was conducted at the February meeting of the A.I.M.E. The papers there presented and the ensuing discussion have been boiled down and published in a separate bulletin of 119 pages, obtainable from the Secretary of the A.I.M.E., 29 West 39th St., New York City; price to nonmembers not stated.



A 70-ton side-dump car which has been developed for heavy work on the iron ranges of Lake Superior. It is dumped by the dumper shown below

New Machinery and Inventions

A Car Dumper of a New Type

The illustration presented herewith shows a unique form of car dumper which has recently been developed to dump a special form of car which is particularly adapted to the heavy service in quarrying and mining operations when steam shovels are used to load the cars.

In quarrying operations for large cement plants, many different types of cars have been tried and found incapable of standing up satisfactorily under the extremely severe service which is encountered where large steam shovels are used to load the cars. This is the case in practically every large operation where it is necessary to get large capacity at minimum cost.

Some years ago the Atlas Car & Manufacturing Co., of Cleveland, Ohio, developed a special type of car for these quarrying operations, which has given satisfactory service and which is rapidly becoming standard for quarry use under the conditions mentioned. This car consists essentially of a truck or frame which is mounted in the usual way on extra heavy wheels and axles with heavy journal bearings and spring pedestals to protect the equipment. The body or hopper of the car is made of an entirely separate unit of extremely heavy construction. It rests directly on the framework when carrying the load, but when the car reaches the dumping point the hopper is tilted so that the contents can easily slide out, generally into the chute to the crusher.

This construction has important advantages. In the first place, there are no moving parts or mechanism to get out of order. The hopper is simply dropped in place and automatically held by suitable blocking. When it is tilted, a hoist of some type is used, but there is no machinery on the car. It will be obvious that this is an efficient arrangement in view of the fact that ordinarily but one hoisting rig is provided for a large number of cars, and aside from the annoyance and cost of maintaining dumping mechanism on all the cars, it is far simpler and certainly far cheaper to have only one dumping station which can and does receive the proper attention at far less cost than that involved in the maintenance of all the cars.

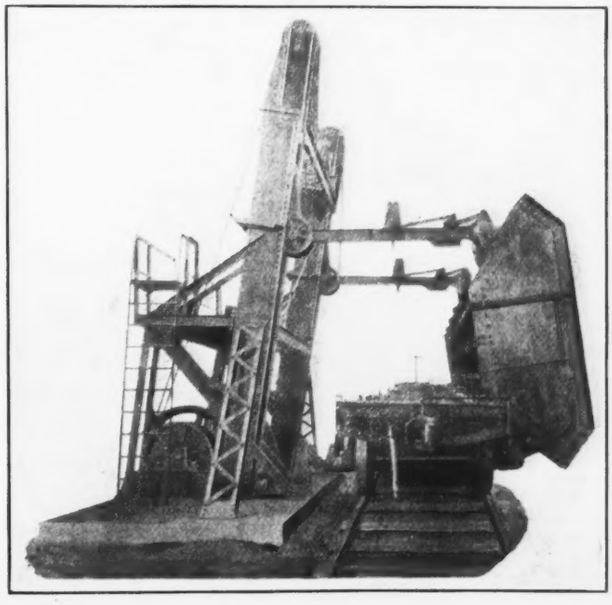
An additional advantage is that if any of the hoppers or bodies are damaged by the fall of large rocks, it is a simple matter to throw the damaged body aside until it can be repaired and replace it with a spare hopper. The entire design of the car lends itself particularly well to rigid construction.

On the iron ranges it has been generally the practice to use air operated side-dump cars, and every operator knows that these are difficult and expensive to maintain. It was concluded that the type of car which was found satisfactory for quarry service would also be satisfactory for heavy range work. The cut shows a 70-ton capacity car developed particularly for this service, which is rugged enough to stand the most severe abuse. To handle this large capacity car a special form of dumper was necessary and the Atlas company finally designed and built the dumper shown, which operates satisfactorily.

The particular feature of this dumper is that the operator has absolute control of the dumping hopper at all times, as the hopper is rigidly connected to the dumping device in such a manner that the hoist can be stopped at any point, or, if necessary, the hopper can be shaken so as to loosen any material which should happen to stick in it.

The operation of the hoist is as follows: The loaded car is brought into position in front of the hoist, and the operator starts operation by hoisting the two trolleys to which the dumping arms are connected. These dumping arms automatically lock to suitable trunnions on the car hopper, and as the trolleys are hoisted the body is forced up and over to the dumping position, but always under absolute control of the operator. Replacing the body simply means reversal of these operations.

Though the car shown is of 70 tons' capacity, the dumper can be made to fit a car of any capacity.



After the car is spotted in front of the hoist the operator starts by hoisting the two trolleys. The dumping arms are connected, automatically locking to suitable trunnions on the car hopper. As the trolleys are hoisted the body is forced over into the dumping position.

Three New Portable Electric Tools

What it calls its No. 2 electric tapper has recently been added to its line by the Black & Decker Manufacturing Co., Towson Heights, Baltimore, Md. The new feature of this model is that the mechanism in the gear case is so designed that the tap is driven in at a speed of 350 r.p.m. and, by a slight backward pull on the machine, the tap chuck is automatically reversed and the tap backed out of the threaded hole at double the speed it is driven in. No reversing switch is needed.

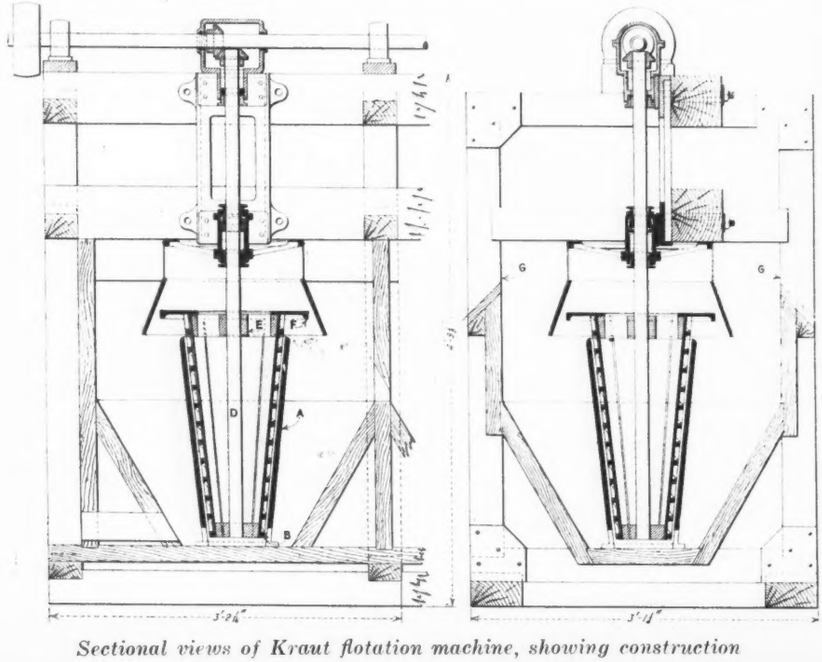
In line with its practice of adapting the electric drive to hand tools having a rotating motion, the Black & Decker company has also recently introduced its No. 3 reversible electric socket wrench, which is adapted to assembling and disassembling gasoline motors or any other similar type of machinery. In this machine the spindle is provided with a clutch which automatically releases when the forward pressure on the tool is relieved. Due to the design of this clutch, a nut, bolt or stud can be driven to any desired tightness. A reversing switch is provided for use in disassembling motors and machinery and the wrench has ample power to kick loose nuts or bolts regardless of how tight they are drawn up. The machine is equipped with a quick-change chuck for holding the different size socket wrenches.

Kraut Flotation Machine

Significant economy in power consumption is presaged in the development, by M. Kraut, well known in metallurgical circles by reason of his former invention, the K. & K. machine, of a new flotation unit provided with a novel and ingenious method of insuring aëration. The invention consists essentially of the usual box, characterized by depth rather than breadth or length, in which is placed a metal container, *A*, with ports near the bottom, *B*, for the entry of pulp, the depth of which in the unit, or series of units, is maintained according to the level of overflow. Inside the stationary container revolves, at 800 r.p.m., the aërating member, of molded hard rubber, the surface of which, facing the container, is provided with a series of helices, between and behind which eight vertical slots are provided to allow the passage of air from the space *D*, in which it is maintained at slight pressure by the provision of vanes *E*. A baffle, *F*, also of hard rubber, deflects the pulp downward below the pulp level.

In operation, the unit receives pulp in the usual manner. This passes to the bottom of the apparatus, being deflected by false sides toward the entry *B*. The effective part of the revolving member is submerged, and its circular motion tends to force or suck the pulp upward in the narrow space between it and the stationary member, this motion being due for the most part to the helices provided. With enlarging diameter, the peripheral speed of the rotary member increases in regular ratio from the bottom to the top, thereby insuring a definite and progressively effective suction of air through the channel ports, this suction being aided by the pressure caused by the movement of the vanes *B*.

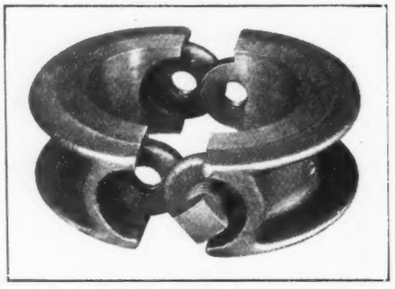
Each unit is provided with two froth overflows, at opposite sides. The frothing area provided is 5 sq.ft. per unit, and the capacity can be based on the assumption that ¼ sq.ft. of frothing area is required per ton of ore per twenty-four hours. The power required per unit is about ¾ hp. Floor space required is unusually small. The machine is being manufactured by the Bunting Iron Works Co., with offices at the First National Bank Building, San Francisco, and works at Berkeley, Calif.



Sectional views of Kraut flotation machine, showing construction

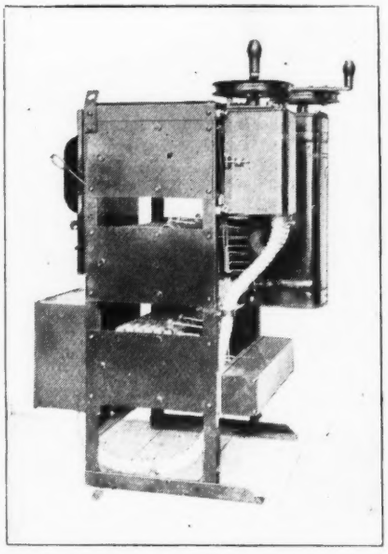
A New Malleable Iron Safety Collar

It is estimated that 10 per cent of the power generated in the average industrial plant is wasted between the generator and the consuming machine. Attention to this loss of power has given rise to changes in power-transmission equipment and the development of more efficient mechanical means. A recent development along this line, in the form of a new malleable iron safety collar, which is shown in the accompanying cut, comes from the Link-Belt Co., of Indianapolis. This new safety collar is intended to maintain the proper alignment of such equipment as pulleys, shaft bearings, hangers, and the like.



This malleable iron safety collar is split in two pieces, making installing or adjusting easy

Strength, toughness, durability, and light weight are claimed for this collar. Te design, which is new, permits the collar to be split in two pieces.



Control equipment for use with 30/15 hp. two-speed oil well motor

A Self-contained Controller for Oil-well Motor Equipment

The controller shown in the accompanying cut has been developed by the Cutler-Hammer Manufacturing Company, of Milwaukee, for use with the two-speed pole-changing type of wound rotor induction motors which is being used in increasing numbers for pumping and cleaning oil wells. This controller, it is claimed, gives the operator complete control so that he may start it, run it at the low speed as when pumping, vary this pumping speed, or change over to the higher speed (twice the low speed) when pulling, cleaning out, or bailing. This speed may also be varied.

The controller is assembled as a complete unit so that it may be easily transported and set up. The smaller of the two drums is manipulated to change over from one of the two running speeds to the other. The larger provides the means for starting the motor and regulating speed. In addition to operating handles, both drums have sheave wheels, since pumpers usually are stationed at the headache post on the rig and operate the motor by means of a cable.

To complete the control equipment there is an inclosed triple pole fused main line switch with an outside-operated handle and a protective panel which guards against damage due to overload and unexpected interruption of power supply. The resistance grids which are in circuit when accelerating the motor or varying the speeds are mounted inside the framework.

Trade Catalogs

Power Transmission—Catalog No. 31 of the W. A. Jones Foundry & Machine Co., Chicago, Ill., covers shaft hangers, pillow blocks, couplings, collars, belt tighteners, mule stands, bench legs and other power-transmission machinery and appliances. Catalog No. 32 of the same company covers a full line of sprocket wheels and chain belting.

The Market Report

Daily Prices of Metals

Jan.	Copper N. Y. net refinery	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
1	.....	.....	.....	....	....	.....
2	14.75	59.25	59.875	9.85	9.80	7.80
3	14.75	59.875	60.50	9.85	9.80	7.80
5	14.80	59.75	60.375	10 075	9.90	7.85
6	14.75@14.875	59.50	60.125	10.075	9.85	7.85
7	14.80@14.875	59.375	60.00	10.075	9.85	7.825@7.85
Av.	14.79	59.55	60.175	9.985	9.84	7.828

*These prices correspond to the following quotations for copper delivered: Jan. 2d and 3d, 15c.; 5th, 15.05c.; 6th, 15@15.125c.; and 7th, 15.05@15.125c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electro-lytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
1	...	...	...	....	....	...	...	...	....
2	67¼	68⅜	71½	274½	277⅞	43⅛	40 13/16	38⅝	38 5/16
5	67⅞	69	71⅜	277½	280⅞	43¼	41	38½	38 5/16
6	67¼	68⅜	71½	273¼	277¼	43½	41⅜	38⅜	38 5/16
7	67¼	68⅜	71½	274½	278½	43⅛	41	38½	38⅛

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
1	....	....	31¾	87s 9d	5	4.76	68½	32 5/16	87s 4d
2	4.74⅜	67	31¾	87s 9d	6	4.75¼	68½	32⅜	87s 7d
3	4 75	67½	32	.....	7	4.76¼	67¾	31 15/16	87s 5d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Lead Reaches Highest Price in Seven Years

New York, Jan. 7, 1925—The nonferrous metal markets have been unusually quiet all week, most consumers being in the midst of annual inventories and not interested in buying until their stocks are determined. Prices have advanced further, however, owing to the continued excellent consumption both here and abroad, and to the growing feeling by producers that production cannot be increased greatly above present figures unless a better supply of labor is available. The continued strength in the stock market, also, without a doubt, has had a sympathetic effect on metal prices.

Copper at Last Reaches 15c.

In the last three days practically all producers have been quoting 15¼c., delivered, after holding at 15c. last Friday and Saturday. Sales have not been large, as most of the consumers are temporarily out of the market, having provided for their immediate requirements and apparently feeling that 15c. may prove to be a stable level above which prices will not advance much. However, several million pounds have been sold for Eastern delivery at the 15½c. level, though mostly for March and April shipment. On Monday and Tuesday, small tonnages were available for early delivery to near-by points at 15c., but today it was impossible to find any more at this price; one good-sized lot was sold, however, at 15.05c.

A temporary lull in buying seems to have little effect in causing sellers to throw metal on the market, as most all of them are well sold up, and would be glad to have slightly larger stocks of both blister and refined copper so as to secure maximum efficiency in refining and shipping. Indications are that the 15c., delivered, price will prove no barrier to the advance.

The export market has not been active since the first of the year, but there, too, prices have shown no weakness. In the last three days moderate sales of copper have been made to European points, mostly at 15.20@15.25c., c.i.f.

Lead Above 10c., New York

The official contract price of lead, New York, set by the American Smelting & Refining Co. was advanced from 9.65 to 9.75c. on Friday, Jan. 2, and on Monday, Jan. 5, a further advance to 10c. was made.

Conditions in the lead market are unchanged so far as demand and supply are concerned. Inquiries are far beyond the ability of producers to meet. Small amounts of lead are always available at premium prices, but the principal producers are closely limiting the tonnages sold at their quoted prices. On Friday and Saturday, lead was obtainable in New York at from 10 to 10¼c., and in the last three days at from 10¼ to 10.40c., but the tonnage sold at these levels was not nearly so great as that going out at 9.75 and 10c. respectively. In St. Louis a similar condition obtains, the leading producer quoting 9½c. on Friday, and 9¾c. on Monday and succeeding days. A considerable tonnage of lead was sold in St. Louis on Monday at 10.05c., but since then, 10c. seems to be about as high as the smaller producers and dealers can get.

Although lead prices are the highest since the first of September, 1917, and not so very far below the war-time peak of 11½c., there seems to be little substitution with other metals, so far, or cessation of buying lead products because of the price. With lithopone obtainable at 6c. per lb., paint manufacturers may be tempted to use a smaller proportion of lead, but the ultimate cost of paint on a building is not greatly different whether lead is 5 or 10c. Lead for covering cable can hardly be substituted by any other metal, and lead seems to be essential for batteries for most purposes. Of course, our chewing gum may be wrapped in waxed paper instead of foil, but most of such places where substitution can be made account for a comparatively small tonnage of lead. Apparently, the solution of the problem lies in greater production, and with prices firmly at 10c. or above, it is almost certain that a con-

siderably greater tonnage will be forthcoming. Foreign sources of supply seem to be more promising than domestic.

Zinc Quiet but Firm

Sales of zinc were of comparatively small volume during the week, but with advancing prices of concentrates, and after the large amount of business done recently, sellers were in no mood to sacrifice the metal to make sales. In the last three days the market has held very close to 7.85c., a slight advance from last week. Some zinc was also sold for export. The demand for high-grade continues good, with 8¾c. generally quoted for Eastern deliveries by all producers.

Tin Reaches 60c.

Tin prices continued to advance, and a good business was done for both spot and forward metal, and to all classes of consumers. At the recession in price on Tuesday, business was particularly active and the price was quickly bid up to above 60c. at the close. Consumption is probably well beyond production at present, and additional supplies will be needed. South American producers can make a good profit at 60c. and will probably increase their output considerably. The 99 per cent grade is in somewhat freer supply than for some time. Forward Straits ranges from the same prices as quoted for spot to ¼c. premium. Arrivals of tin at United States ports to and including Jan. 6 total 2,360 long tons.

Silver Quotations Unsteady

Silver had a very sharp advance caused by heavy buying on the part of the India bazaars, but the rise was overdone and China sales forced a reaction on Jan. 7.

Mexican Dollars: Jan. 1st, holiday; 2d, 51⅝c.; 3d, 52⅛c.; 5th, 52⅜c.; 6th, 52⅜c.; 7th, 52⅛c.

Sterling Continues Advance

Sterling exchange continued its advance towards par, touching a new high today. On Tuesday, Jan. 6, closing cable quotations on francs were 5.395c.; lire, 4.22c.; and marks, 23.81c. Canadian dollars, 11/32 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, £125 per long ton.

Antimony—Per lb.:
Chinese brands, 17⅞@18c.
Cookson's "C" grade, 19½c.

Chinese needle, lump, nominal, 10c.

Standard powdered needle, 200 mesh, 11½c.

White oxide, Chinese, 99 per cent Sb_2O_3, 13@14c.

Bismuth—$1.25@$1.30 per lb. London, 5s.

Cadmium—60c. per lb. London, 2s. 2d.@2s. 6d.

Iridium—$325 per oz.

Nickel—Ingot, 31c.; shot, 32c.; electrolytic, 38c.; London, £162½ per long ton.

Palladium—$79@$83 per oz. Crude, $60@$65.

Platinum—$117 per oz. for refined. Crude, $111.

Quicksilver—$78@$80 per 75-lb. flask. San Francisco wires $80.35. Quiet. London, £12⅝.

The prices of **Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmiridium, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten,** and **Zirconium** are unchanged from the prices given in the Jan. 3 issue.

Metallic Ores

Tungsten Ore—Per unit, N. Y.:
Chinese wolframite, $9.
High-grade Western scheelite, $9.50.

Chrome, Iron Ore, Galena Radio Crystals, Manganese, Molybdenum, Tantalum, and **Vanadium Ores** are unchanged from Jan. 3 quotations.

Zinc and Lead Ores Still Advancing

Joplin, Mo., Jan. 3, 1925

Zinc Blende	Per Ton
High	$62.30
Premium, basis 60 per cent zinc	$59.00@$60.00
Prime Western, 60 per cent zinc	$57.00@$58.00
Fines and slimes	$56.00@$54.00
Average settling price, all ores	$51.17
Lead Ore	
High	$134.60
Basis 80 per cent lead	$137.50@$140.00
Average settling price, all ores	$122.79

Shipments for the week: Blende, 15,301; lead, 2,817 tons. Value, all ores the week, $1,128,960.

Purchases today for next week's delivery of 9,050 tons, added to the tonnage already purchased ahead of delivery, approximate a total of 25,000 tons of ore under contract.

Though the quotation of Prime Western is given as above, reports are to the effect that ore was sold on the same level as premium blende.

Lead is known to have sold on $137.50 basis, with the claim of sellers that $140 offerings were made.

Platteville, Wis., Jan. 3, 1925

Zinc	Per ton
Blende, basis 60 per cent zinc	$57.00
Lead	
Lead, basis 80 per cent lead	$135.00

Shipments for the week: Blende, 708 tons; lead, none. Shipments for the year: Blende, 33,008; lead, 1,716 tons. Shipments for the week to separating plants, 1,289 tons blende.

Non-Metallic Minerals

Feldspar—per net ton, in bulk, f.o.b. mill.

No. 1 Porcelain grade (Virginia) 140 mesh, $22; No. 1 Body spar (Maryland) 120 mesh, $17; Enamelers' grade (Maryland) 80-100 mesh, $13.50@$16; Enamelers' grade (Virginia) 100 mesh, $20; Glassmakers' grade (Virginia) 30-100 mesh, $19; Glassmakers' grade (Maryland) 30-100 mesh, $13@$15.

Other feldspar quotations in Jan. 3 issue.

Amblygonite, Asbestos, Barytes, Bauxite, Beryl, Borax, Celestite, Chalk, China Clay, Corundum, Diatomaceous Earth, Emery, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Ozocerite, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystals, Rutile, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from Jan. 3 prices.

Mineral Products

Arsenious Oxide (white arsenic)—6½c. per lb.

Copper Sulphate, Sodium Nitrate, Sodium Sulphate, and **Zinc Oxide** are unchanged from Jan. 3 prices.

Ferro-Alloys

Ferromanganese—Domestic, German, and English, $110 per gross ton, f.o.b. works, or duty paid at seaport.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and Ferrovanadium are unchanged from the prices given in the Jan. 3 issue.

Metal Products

Copper Sheets and **Wire, Nickel Silver, Yellow Metal, Lead** and **Zinc Sheets,** unchanged from Jan. 3 quotations.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick, and **Zirkite are unchanged** from Jan. 3 prices.

Iron and Steel Firm

Pittsburgh, Jan. 6, 1924

The steel market has been rather quiet in the last week in point of actual turnover, but conditions generally are strong. Steel mills, on the whole, are booked fairly well for the current quarter. In rails and tin plate they are booked nearly full for the half year.

Finished steel prices are very firm. Further advances are predicted by producers.

Steel mills operated at about 80 per cent in December, and are expected to average above that in the present quarter. Operations averaged 80 per cent in 1923 and 68 per cent in 1924.

Semi-finished steel is quotable nominally at $38 for billets, $39 for sheet bars and $43 for forging billets. The billet price has not been tested in actual sales, while it is somewhat doubtful whether sheet bars could be bought at under $40, which is the present asking price. The market until two or three weeks ago was $36 for billets and $37 for sheet bars.

Pig Iron—The market has been quiet, but prices are firm and advances are predicted: Bessemer, $22.50@$23; basic, $21.50@$22; foundry, $22@$23, f.o.b. Valley furnaces, with $1.76 freight to Pittsburgh.

Pig-iron averages for 1924 follow: Bessemer, $23.28; basic, $22.01 per ton.

Connellsville Coke—There is little free coke and very little demand. Spot furnace, $4.25@$4.50; spot foundry, $5@$5.50. On furnace coke contracts $5 is asked for first quarter and $6 for second quarter, prices which do not interest consumers.

The Copper, Zinc, and Potash Situation in Germany

By Dr. James Rubinfeld
Charlottenburg, Germany

THE MANSFELD COPPER CO. of Eisleben has reduced the nominal value of its shares to 37,500,000 reichsmark (the present final currency medium of Germany) and hopes to pay dividends on this small capitalization in the future. The company plans to establish new plants and to reorganize and modernize its mills and refineries upon an American model, and to turn out electrolytic instead of casting copper. Already its copper output has increased greatly and its silver output in 1924 should be 90,000 kilos, compared with 70,000 in 1923. Copper demands are very buoyant here at the moment, the middle-sized foundries and moulders having at last made their appearance again, as in pre-war times. To counterbalance the heavy inquiries for copper, the aluminum works of Germany, which are partly owned by the Reich, have cheapened the substituting metal by around 10 Swiss centimes (the currency in which the metal is sold here) for a kilo. This price reduction is rather remarkable, as the German works are tied up with the other European aluminum producers who were decidedly unwilling to lower prices so long as the American trust refrains from pouring the commodity at cut prices upon the European markets, which contingency is a kind of bogey in European aluminum circles. But it must be pointed out that the requirements of copper by the German postal and railway services, heavy as they are at present, would be much more so were it not for the adoption of aluminum alloys and wire instead of copper for many processes. On the other hand the spreading of radio broadcasting all over Germany, with its wide appeal to all classes, is likely to absorb a great quantity of copper wire, and Germany is in this as in other manufacturing fields a great source of supply for the Balkan and eastern countries.

German Building Trades Reviving

The revival of the building trades in Germany is another factor which promises well, and already galvanized sheets of every kind are being ordered from all available sources of supply, for delivery in the coming spring, resulting in the all-round abandonment of short-time labor in zinc and lead manufacturing mills of the Ruhr and German Upper Silesian districts. An undercurrent of alarm is felt here at the British scheme to withhold Australian zinc concentrates from the European smelters, which would necessitate an appeal to America for supplies. The pre-war relations to Belgian zinc mills are only gradually being resumed, and the old conditions should not be anticipated for some time yet.

German Potash Production Well Organized

Some people point out that it should be possible to maintain the same good relations with Belgium as the Alsatian potash concerns do with regard to operations in the United States markets; but in truth, zinc matters have a thoroughly different complexion than those of the potash trade, for, whereas there are only fifteen potash mines in Alsace now working, there are now operating 176 powerful and excellently organized potash mines in Germany. The French mines have not near the capacity of the German mines, and they lack sulphatic ingredients in the potash, whereas Germany can build a mighty chemical trade upon the output of kieserite and allied salts, and would always be able to complete with the French abroad, so that the readiness of the French producers to co-operate is well conceivable. As a matter of fact, it may be stressed that the Wintershall interests, which enjoy a quota of about 40 per cent in the Potash Syndicate, are decidedly averse to co-operation with the French, on the plea that the concessions made to the latter are far too liberal. Also, the unfortunate compulsory legislation for the potash trade of this country is said to be handicapping principally the progressive and best-organized parts of it, the management of the Syndicate allotting scrupulously the amount of market openings to all members; that is to say, the less efficient are making the general price level of a basic industry a high one. But the other concerns, as those of Salzdetfurth, Burbach, or Gumpel, are stubbornly opposing the plans of Wintershall and its effort to free the trade from legislative chains.

Imports and Exports of Ores and Metals in November, 1923 and 1924

Imports and exports of certain metals and ores during November, with revised comparative figures for November, 1923, as compiled by the U. S. Department of Commerce, are as follows:

Imports

In Pounds, Unless Otherwise Stated

	November, 1923	November 1924
Antimony		
Ores	128,931	201,920
Liquated, regulus or metal	986,272	515,872
Copper		
Ore	7,456,229	17,028,329
Concentrates	5,202,467	2,654,488
Regulus, coarse metal and cement copper	.....	21,159
Total	12,658,696	19,703,976
Unrefined, black, blister and converted copper in pigs, bars and other forms	44,438,675	48,686,075
Refined copper	3,006,859	16,496,505
Old and clippings for remanufacture	191,771	511,277
Composition metal, copper chief value	.....	412
Copper manufactures	8,424	22,394
Brass		
Old and clippings for remanufacture	523,522	725,807
Manufactures of brass	102,521	97,847
Lead		
Ore and matte	17,457,951	5,243,286
Bullion or base bullion	17,813,966	13,198,374
Pigs, bars, other forms and old	4,761	643,638
Manufactures of, except type metal	26,328	38,147
Manganese ore, long tons	14,790	19,919
Pyrites, long tons	40,063	15,855
Tin		
Tin ore, tons	.....	35
In blocks, bars and pigs	11,336,361	9,386,703
Zinc		
Ore—Free	.....	.....
Dutiable	416,463	621,245
Blocks, pigs, other forms	4,253	.....
Zinc dust	9,123	8,096

Exports of Copper, Lead, and Zinc

In Pounds

	November, 1923	November, 1924
Copper		
Ores, concentrates, matte and regulus	.....	11,297
Copper and manufactures of	87,279,280	104,882,777
Refined in ingots, bars and other forms	77,704,555	97,562,168
Old and scrap copper	195,924	490,027
Composition metal, copper chief value	31,869	3,148
Pipes and tubes	187,102	133,301
Plates and sheets	399,703	241,206
Rods	5,761,770	4,603,002
Wire	818,497	629,561
Insulated copper wire and cable	1,026,974	1,083,919
Other manufactures of copper	1,152,886	136,445
Lead		
Pigs, bars and other forms		
From domestic ore	412,509	949,528
From foreign ore	9,287,988	10,452,861
Zinc		
Ores, concentrates and dross	1,449,747	2,781,797
Zinc (spelter) in slabs, blocks or pigs	12,712,437	19,640,717
In sheets, strips, and other forms	663,114	805,315
Zinc dust	498,195	281,970
Other zinc manufactures	35,831	107,402

Mining Stocks at Auction

The following lots of mining stocks were recently sold at auction in New York City:

	Price for the lot
4,000 shares Sunbeam Gold Mining & Milling Co. ($1 each)	$45
25 shares River Feldspar & Milling Co. pfd. ($100), and 25 shares common ($100)	20
160 shares River Feldspar & Milling Co. pfd., and 160 shares common	40
50 shares River Feldspar & Milling Co. pfd., and 50 shares common	20
10,000 shares Homestake Extension Mining Co. ($1)	1,000
50,000 shares Nellie Mining Co. of Arizona ($1)	225
433 shares Union Copper Mines ($5), 250 shares of old Rock Island stock, and 25 shares Viereck Pub. Co.	5
$70,000 General Mines Corp. of Bolivia, 7 per cent collateral trust bonds due Jan. 1, 1934	10,500
200 shares Southwest Metals Co. (no par)	35
100 shares Tezuitlan Copper Mining & Smelting Co. ($100)	30
10,500 shares San Antonio Copper Co. (7,000 shares fully paid and 3,500 shares $3.50 paid) ($10)	875
7,000 shares Sierra Consolidated Mines (2,000 shares fully paid and 5,000 shares $7 paid) ($10)	450
26,050 shares Nevada United Mining Co. ($1)	250
3,200 shares Copper Canyon Mining Co. of Delaware ($1)	110
1,000 shares Rawhide Coalition Mines Co. of Nevada ($1)	2
100 shares The Phosphate Mining Co.	3,500
11,000 shares Montana & Mexico Mining Co., Inc., of Delaware ($5)	1
125,040 shares Lincoln Mining & Development Co.	25
12,500 shares Banner Consolidated Mines Inc. ($1)	150
481½ shares Durango Copper Co. of New York ($10)	5
200 shares Premier Extension Gold Mining Co., Ltd. ($5)	20
1,000 shares Hard Shell Mining Co. ($1)	10
1,000 shares Morrington Mining Co. ($1)	5

Mining Stocks

Week Ended January 3, 1925

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Alaska-Br. Col.	N. Y. Curb			*6		
Anaconda	New York	48¼	46⅞	48	Ja.17, Fe.16,	0.75
Arcadian Consol.	Boston	3⅛	3	3		
Ariz. Com'l	Boston	15⅜	14	15¼	Jy.19, Jy.31	0.50
Calaveras	N. Y. Curb			2		
Calumet & Arizona	Boston	*58¼	*55¼	*56½	De.5, De.22 Q	0.50
Calumet & Hecla	Boston			18	My. 31, Jn. 16	0.50
Canario Copper	N. Y. Curb	4¼	4	4⅛		
Cerro de Pasco	New York	56⅜	53⅞	54⅞	Oc. 23, No. 1	1.00
Chile Copper	New York	38⅜	36⅛	37	De.3, De.29, Q	0.62½
Chino	New York	29	27½	27½	Sept., 1920	0.37½
Con. Coppermines	N. Y. Curb	3⅜	3 3/16	3⅜		
Copper Range	Boston	33¼	31¼	31¼	May, 1923	1.00
Crystal Copper	Boston Curb	*60	*50	*60		
Davis-Daly	Boston	*68	*50	*57	Mar., 1920	0.25
East Butte	Boston	5⅝	6	6	Dec., 1919	0.50
First National	Boston Curb	*35	*31	*35	Feb., 1919	0.15
Franklin	Boston			*90		
Gadsden Copper	Boston Curb	*64	*63	*64		
Granby Consol.	New York	21⅛	20	20⅛	May, 1919	1.25
Greene-Cananea	New York	21⅞	18⅛	19¼	Nov., 1920	0.50
Hancock	Boston	2	1⅞	1⅞		
Howe Sound	N. Y. Curb	3⅜	3	3⅛	Ap.1,Ap.15, Q	0.05
Inspiration Consl	New York	33⅞	31⅛	32⅝	De.20, Ja.7, Q	0.50
Iron Cap	Boston Curb	2⅛	2	2⅛	May, 1923	0.15
Isle Royale	Boston	*22½	*19½	*19½	Se. 1, Se. 15	0.50
Jerome Verde Dev	N. Y. Curb	*99	*98	*98		
Kennecott	New York	57⅝	55⅛	56¼	De.2, Ja.2, Q	0.75
Keweenaw	Boston			1⅛		
Lake Copper	Boston	3⅛	2½	2⅛		
Magma Copper	New York	45⅜	42	42⅜	Jan., 1919	0.50
Mason Valley	N. Y. Curb	2⅛	2⅛	2⅛		
Mass Consolidated	Boston	1⅜	1	1⅜	Nov., 1917	1.00
Miami Copper	New York	24⅛	22⅛	22⅛	No.1 No.15 Q	0.50
Mohawk	Boston	40⅜	37⅛	37⅞	Se. 22, Oc. 13	1.00
Mother Lode Coa	New York	9⅛	9	9⅛	De. 12, De. 31	0.37½
Nevada Consol.	New York	16⅛	15⅝	16	Sept., 1920	0.25
New Cornelia	Boston	25⅜	24⅛	24⅞	No. 7, No. 24	0.25
New Dominion	N. Y. Curb			2⅞		
North Butte	Boston	3⅛	3	3	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1⅞	1 7/16	1 7/16	No.14, De.2	0.05
Old Dominion	Boston	27⅛	25⅛	25¼	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†110	†107		De.2, Ja.2 Q	1.00
Quincy	Boston	39⅛	30⅛	30⅛	Mar., 1920	1.00
Ray Consolidated	New York	17⅞	16⅛	16⅛	Dec., 1920	0.25
Ray Hercules	N. Y. Curb	*15	*9	*13		
St. Mary's Min. Ld.	Boston	49	44⅞	45	Ap.22, My.20	3.00
Seneca Copper	New York	1⅛	1	1⅛		
Shannon	Boston	1⅛	1⅛	1⅛	Nov., 1917	0.25
Shattuck Arizona	New York	8	7⅞	7⅞	Jan., 1920	0.25
Superior & Boston	Boston	2	1⅞	1 15/16		
Tenn. C. & C.	New York	9⅛	9	9	De.31, Ja.15,Q	0.25
United Verde Ex	N. Y. Curb	30	29⅛	29⅝	Ja. 2, Fe. 2	0.50
Utah Copper	New York	88⅛	86	87⅞	De.12, De.31,Q	1.00
Utah Metal & T	Boston	*48	*45	*45	Dec., 1917	0.50
Victoria	Boston	*99	*95	*99		
Walker Mining	N. Y. Curb	3 11/16	3⅜	3⅜		
Winona	Boston			*50		
NICKEL-COPPER						
Internat. Nickel	New York	27⅛	25⅛	27⅛	March, 1919	0.50
Internat. Nickel pfd.	New York	95	93⅞	94¼	Oc.16, No.1, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	4⅜	3⅞	4⅛		
National Lead	New York	162¾	158	162	De.12, De.31, Q	2.00
National Lead pfd.	New York	116¼	116	116¼	No.21,De.15, Q	1.75
St. Joseph Lead	New York	46	44⅜	45¼	De. 9, De. 20	0.50
ZINC						
Am. Z. L. & S.	New York	12⅛	11⅛	11⅛	May, 1920	1.00
Am. Z. L. & S. pfd.	New York	36⅞	34⅜	34⅜	Nov., 1920	1.50
Butte C. & Z.	New York	9⅛	8⅜	8⅜	De.10, De.24	0.50
Butte & Superior	New York	25	22⅛	22⅜	June, 1924	0.50
Callahan Zn-Ld	New York	4⅞	4⅜	4⅛	Dec., 1920	0.50
New Jersey Zn	N. Y. Curb	199⅜	193	198½	Ja.20, Fe.10	2.00
United Zinc	N. Y. Curb			*15		
Yellow Pine	Los Angeles	*75	*70	*75	De.10, De.15 Q	0.4
SILVER						
Alvarado	Boston Curb	1 7/16	1⅜	1⅜		
Beaver Consol.	Toronto	*28	*24½	*26½	May, 1920	0.03
Castle-Trethewey	Toronto	*76	*71	*73		
Coniagas	Toronto			2.20	Ap.20, My.1	0.02½
Crown Reserve	Toronto	*51½	*47½	*50	Jan., 1917	0.05
Keeley	Toronto	2.22	2.13	2.17	Sept. 15, SA	0.12
Kerr Lake	N. Y. Curb	1⅞	1⅞	1⅛	Oc. 1, Oc. 15,	0.12½
La Rose	Toronto	*7½	*6	*6	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto	1.34	1.31	1.31		
McKinley-Dar.-Sav.	Toronto	*20	*14½	*17	Oct., 1920	0.03
Mining Corp. Can.	Toronto	3.09	2.78	3.00	Sept., 1919	0.12½
Nipissing	N. Y. Curb	6⅜	6⅛	6⅜	Ja.18,Ja.20,QX	0.30
Ontario Silver	New York	6⅛	6¼	6⅛	Jan., 1919	0.50
Temiskaming	Toronto	*30	*20	*20	Jan., 1920	0.40
GOLD						
Alaska Gold	New York	*16	*12⅛	*16		
Alaska Juneau	New York	1⅛	1⅛	1⅛		
Argonaut	Toronto	*38	*28½	*34		
Carson Hill	Boston	*70	*50	*50		
Consol. W. Dome L.	Toronto	*18½	*15½	*17		
Cresson Consol. G.	N. Y. Curb	3¼	3⅛	3⅛	De.31, Ja.10 Q	0.50

Stock	Exch.	High	Low	Last		Last Div.
Dome Mines	New York	13⅝	13⅛	13¼	De.31, Ja.20, Q	0.50
Golden Cycle	Colo. Springs			1.38	Dec.11, 1924	0.03
Hollinger Consol.	Toronto	15.65	15.20	15.55	De.11, De.31,	0.05
Homestake Mining	New York	43	40½	43	De.11, De.26,M	0.50
Jib. Cons'd	N.Y. Curb	*58	*46	*55		
Kirkland Lake	Toronto	*37	*30	*35		
Lake Shore	Toronto	4.80	4.50	4.56	De.1,De.15,QX	0.10
McIntyre-Porcupine	New York	17	15⅛	16⅛	No. 1, De. 1	0.25
Newray	Toronto	*26	*24	*24		
Night Hawk Pen.	Toronto			*4		
Portland	Colo. Springs	*40	*40	*40	Oct., 1920	0.01
Teck-Hughes	Toronto	1.27	1.22	1.25		
Tom Reed	Los Angeles	*40	*21	*40	Dec., 1919	0.02
Tough-Oakes	Toronto	*41½	*35½	*40½		
United Eastern	N. Y. Curb	*35	*35	*35	Jy.18, Jy.31, Q	0.05
Vipond Cons.	Toronto	1.36	1.33	1.35		
Wright-Hargreaves	Toronto	4.50	3.92	4.25	De.15, Ja.2,QX	0.05
GOLD AND SILVER						
Black Oak	N. Y. Curb			*81		
Con. Cortez	N. Y. Curb	*10	*10	*10		
Con. Virginia	San Francisco	9½	9	9⅛		
Continental Mines	N. Y. Curb			1¼		
Dolores Esperanza	N. Y. Curb			*26	Jy.1, Jy.10 Q	0.05
Premier Gold	N. Y. Curb	2½	2⅛	2 5/16	De.22, Ja.5,QX	0.10
Tonopah Belmont	N. Y. Curb	*60	*55	*58	Apr., 1923	0.05
Tonopah Divide	N. Y. Curb	*20	*20	*20	Se. 22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	3 5/16	2 13/16	3⅛	De.11, Ja.1	0.05
Tonopah Mining	N. Y. Curb	1⅜	1⅜	1⅜	Se.20, Oc.31	0.07½
Unity Gold	N. Y. Curb	*66	*57	*57		
West End Consol.	N. Y. Curb			*46	Mar., 1923	0.05
Yukon Gold	N. Y. Curb			*50	June, 1918	0.02
SILVER-LEAD						
Ahumada	Boston Curb	9⅛	8⅛	9⅛	De.15, Ja.2, X	0.15
Bingham Mines	Boston	32	31½	31⅝	De.20, Ja.2	0.50
Cardiff M. & M.	Salt Lake	1.15	1.10	1.15	De.16, No.18	0.10
Chief Consol.	Boston Curb	4	3⅛	3⅜	Ap.19, My.1,Q	0.10
Columbus Rexall	Salt Lake			*26	Aug., 1920	0.03
Consol. M. & S.	Montreal	50	49¼	49⅞	De.11, Ja.15	0.75
Daly Mining	Salt Lake			1.50	July, 1920	0.10
Eruncion	Boston Curb	2⅜	2¼	2⅜	De.15, Ja.2, X	0.15
Federal M. & S.	New York	24⅞	24	24	Jan., 1909	1.50
Federal M. & S. pfd.	New York	64	61	61½	No.25, De.15,	1.75
Florence Silver	Spokane	5⅜	4⅛	5⅜	Apr., 1919, QX	0.01
Hecla Mining	N. Y. Curb	*14	*12¼	*14	No.15, De.15	0.25
Iron Blossom Con.	N. Y. Curb	*26	*26	*26	Oc.25, 1924	0.02½
Marsh Mines	N. Y. Curb	*6	*6	*6	June, 1921	0.02½
Park City	Salt Lake			5	De. 15, Ja.4	0.15
Park Utah	N. Y. Curb			3½	Mc. 15, Ap. 1	0.15
Prince Consol.	Salt Lake	*19½	*16½	*19		
Silver King Coal	Salt Lake	5.95	5.60	5.95	De.20, Ja.2, Q	0.50
Silversmith	Spokane	*30½	*27½	*27½	Ja. 1, Ja. 10	0.02
Tamarack-Custer	Spokane	1.05	*97	*97	Se. 22, Se. 29	0.25
Tintic Standard	Salt Lake	9.00	8.50	8.50	Ja.2, QX	0.50
Utah-Apex	Boston	4⅛	3⅝	4⅛	Ja.10, Ja.15,	0.25
IRON						
Bethlehem Steel	New York	52⅞	49⅞	52½	Jn.1, Jy.1, Q	1.25
Char. Iron	Detroit	*17	*17	*17		
Char. Iron pfd.	Detroit	*70	*70	*70		
Colorado Fuel & Iron	New York	44⅛	42	44	Au.11, Au.25,Q	2.00
Col. Fuel & Iron pfd.	New York			108½	No.10, No.26 Q	2.00
Gt. North'n Iron Ore	New York	36⅞	33⅝	36⅛	De.10, De.27	2.00
Inland Steel	N. Y. Curb			4	No.14, De.1, Q	0.62½
Mesabi Iron	N. Y. Curb			2⅞		
Replogle Steel	New York	22	20	21½		
Republic I. & S.	New York	64⅜	61¼	63⅝	May, 1921	1.50
Republic I. & S. pfd.	New York	94	93½	93⅞	De.16, Ja.2, Q	1.75
Sloss-Sheffield S. & I.	New York	86½	82	85	Se.11, Se.20, Q	1.50
Sloss-Shef. S.&I. pfd.	New York	95⅞	95	95⅞	De.20, Ja.2, Q	1.75
U. S. Steel	New York	123¼	118⅜	122⅛	No.29,De.3, QX	1.75
U. S. Steel pfd.	New York	122⅞	122⅛	122⅜	No.4, No.29, Q	1.75
Virginia I. C. & C.	New York	40	40	40	De.15, Ja.2	1.50
Virginia I.C.&C.pfd.	New York	79	79	79	De. 13, Ja. 2, Q	2.50
VANADIUM						
Vanadium Corp.	New York	41⅞	29⅛	31¼	Jan., 1921	1.00
ARSENIC						
Western Utah Copper	N. Y. Curb			*15		
ASBESTOS						
Asbestos Corp.	Montreal	35½	35	35½	Se.29, Oc.15 Q	1.00
Asbestos Corp. pfd.	Montreal			73½	Ja.2, Ja.15, Q	1.50
SULPHUR						
Freeport Texas	New York	11⅞	10	11⅛	Nov., 1919	1.00
Texas Gulf	New York	109	102½	105¼	De.1,De.15, QX	2.25
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	3¾	3¼	3¾		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	54	52½	53	No.19, De.1 Q	0.75
Amer. Metal pfd.	New York	115½	115½	115½	No.20, De.1, Q	1.75
Amer. Sm. & Ref.	New York	100	96½	99½	Ja.16, Fe.2, Q	1.50
Amer.Sm.&Ref.pfd.	New York	107½	106¼	107⅜	Fe.6, Mh.2 Q	1.75
U. S. Sm. R. & M.	New York	41	37½	38⅛	Jan., 1921	0.50
U.S. Sm. R.&M.pfd.	New York	46⅞	46	46¼	Ja.8, Ja.15	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Colorado Springs, Colorado Springs Stock Exchange.